Assessment of Water Quality in the South Indian River Water Control District, Palm Beach County, Florida, 1989-94

U.S. GEOLOGICAL SURVEY

Open-File Report 96-495

Prepared in cooperation with the

SOUTH INDIAN RIVER WATER CONTROL DISTRICT

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By A.C. Lietz

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Tallahassee, Florida
1996

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Assessment of Water Quality in the South Indian River Water Control District, Palm Beach County, Florida, 1989-94

By A.C. Lietz

Abstract

The South Indian River Water Control District is located in an area of northern Palm Beach County, Fla., where many residents must rely on private wells for domestic water supplies and individual septic tanks for waste disposal. As a result, contamination of the surficial aquifer system and availability of a potable water supply have become of increasing concern. To address this concern, the U.S. Geological Survey, in cooperation with the South Indian River Water Control District, conducted a study to assess ground-water and surface-water quality in the District from 1989 to 1994. The study consisted of water-quality monitoring at 11 wells and 14 surface-water sites located within the District. Water samples were analyzed for major inorganic constituents and physical characteristics, trace metals, nitrogen and phosphorus species, and synthetic organic compounds.

The predominant water type within the South Indian River Water Control District is calcium bicarbonate; however, mixed-ion type water and sodium bicarbonate type water also exist in varying amounts. Sodium chloride type water is present in the western areas of the District due to incompletely flushed residual seawater. Results of the study indicated that concentrations of most constituents were within State drinking-water standards as established by the Florida Department of Environmental Protection, but concentrations of certain constituents occasionally exceeded drinking-water standards in some ground-water and surface-water samples. Sodium and chloride concentrations exceeded the standards in ground water at two wells, dissolved-solids concentrations at five ground-water wells and one surface-water site, and color values at all 11 ground-water wells and all 14 surface-water sites.

Other constituents also exhibited concentrations that exceeded drinking-water standards. Cadmium and zinc concentrations exceeded the standards in ground water at one well, and lead concentrations exceeded the standard in ground water at five wells. Nitrogen and phosphorus specie concentrations did not exceed respective drinking-water standards in any ground-water or surface-water samples. Additionally, organic compounds were not detected at four surface-water sites monitored for National Pollutant Discharge Elimination System constituents. Several synthetic organic compounds were detected at or above 50 micrograms per liter in water samples collected from six ground-water wells and three surface-water sites.

INTRODUCTION

The South Indian River Water Control District is located within the northern Midlands area of Palm Beach County in southeastern Florida (fig. 1). Development of this District, originally known as the South Indian River Drainage District, began during the 1920's with the construction of drainage canals used for agricultural production. Development continued through the 1960's and 1970's with the sale of land for

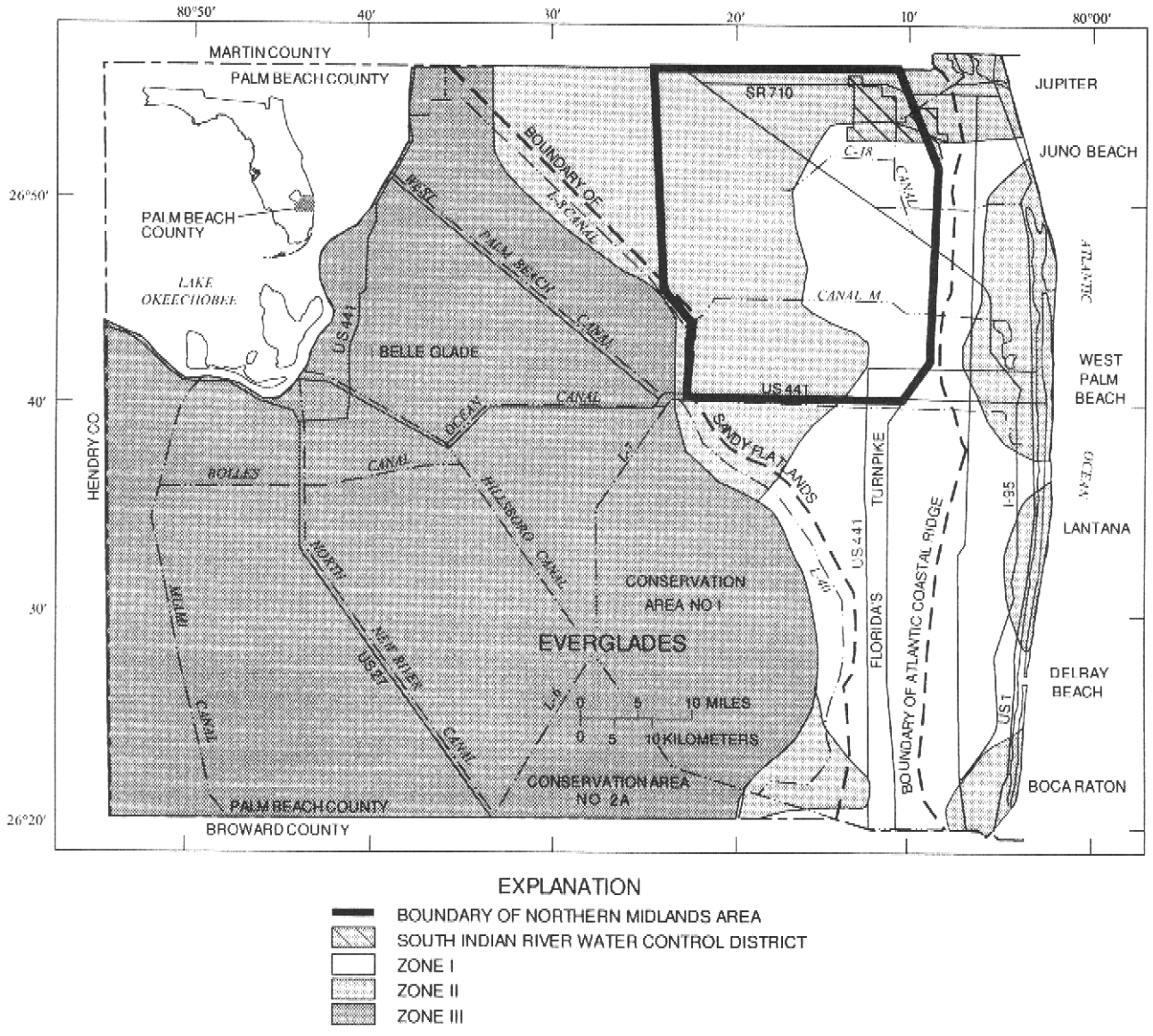


Figure 1. Location of the South Indian River Water Control District, the northern Midlands, and three zones of the surficial aquifer system in Palm Beach County (modified from Miller, 1988).

building residential home sites and with the construction of access roads. In 1983, surface-water improvements to the District's drainage basin (east of the C-18 canal) were implemented. Today (1996), agriculture has been displaced by very low to low density residential housing as the dominant land use, spreading into the northern Midlands area.

The population of the northern Midlands area has grown in recent years with this trend expected to continue, resulting in increased demand for potable water and increased need for waste disposal. Presently, no public-water supplies exist in the area; therefore, many residents must solely rely on private wells for domestic water supplies and on septic tanks for waste disposal. Additionally, pockets of residual Pleistocene seawater that have been incompletely flushed from the surficial aquifer system exist in the western part of the northern Midlands (Miller, 1991, p 12), possibly rendering the water unsuitable for domestic use. The availability of a potable water supply is of utmost concern to water officials and concerned citizens. For this reason, the U.S. Geological Survey, in cooperation with the South Indian River Water Control District, conducted an extensive ground-water and surface-water quality monitoring study from July 1989 to September 1994 to define the baseline water quality within the District and to develop a data base for future water-resources planning and management.

Purpose and Scope

The purpose of this report is to present an assessment of ground-water and surface-water quality data collected in the South Indian River Water Control District. Water samples were collected from 11 ground-water wells and 14 surface-water sites from 1989 to 1994 to determine concentrations of major inorganic constituents and physical characteristics, trace metals, and nitrogen and phosphorus species. Additionally, data were collected from four surface-water sites on a storm-driven basis for determination of synthetic organic compounds that are part of the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) protocol. The gas chromatograph/flame ionization detection (GC/FID) method was used to detect synthetic organic compounds at selected ground-water and surface-water sites. Trilinear diagrams, box plots, and vertical plots were used to compare water quality among sites. Special consideration was given to constituent trends and seasonal variations.

Description of Study Area

The South Indian River Water Control District study area occupies about 20 mi^2 (square miles) in northeastern Palm Beach County and is about 5 mi (miles) inland from the Atlantic Ocean (fig. 1). The study area lies within the physiographic region of the Sandy Flatlands, which, generally is characterized by little topographic relief. The natural land surface ranges from 15 to 18 ft (feet) above sea level (Fisher, 1980).

The South Indian River Water Control District is divided physically and hydraulically into an east-west basin by the C-18 canal (fig. 2). West of this canal, seven lateral canals (C-1 to C-7), spaced at 0.5-mi intervals from north to south, convey water in an easterly direction to the C-14 canal, which flows northward to the Northwest Fork of the Loxahatchee River. The Lainhart Dam acts as a control structure for this section of the drainage basin. Stages in the C-18 canal generally are maintained higher than those in the C-14 canal, and water flows by way of gravity through control structure G-92 to the C-14 canal. East of the C-18 canal, seven canals (A-G) convey water in an easterly direction to the Header Canal, which transports water to the Turnpike Borrow Canal. (Water traverses weirs in canals A, C, D, and E before entering the Header Canal.) Two other canals (J and H) east of the C-18 canal convey water westerly to the Turnpike Borrow Canal. Water in the Turnpike Borrow Canal flows in a north-northwest direction and then parallels the C-18 canal in a north-northeast direction and enters the Southwest Fork of the Loxahatchee River downstream of control structure S-46.

The South Indian River Water Control District is underlain by the surficial aquifer system, the principal source of freshwater supply for Palm Beach County. The surficial aquifer system is composed of many hydrogeologic components that are hydraulically interconnected, but differentiated by variations in lithology and hydraulic characteristics (Miller, 1988, p. 6). The components of the surficial aquifer system are divided into three zones based upon permeabilities (fig. 1). The District lies predominantly in zone II, which is described as the second most permeable zone of the surficial aquifer system.

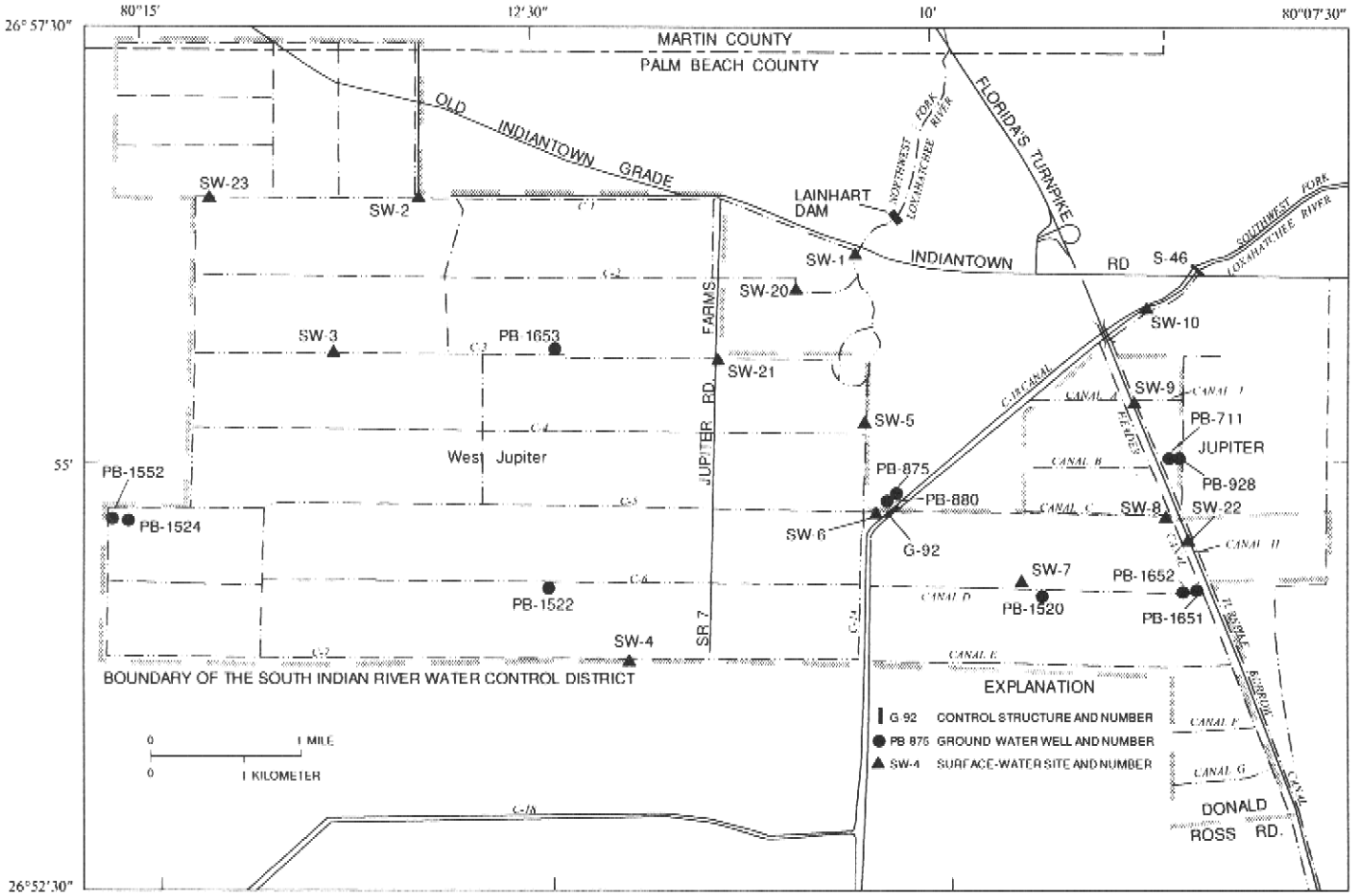


Figure 2. The South Indian River Water Control District showing locations of ground-water wells, surface-water sites, major roads, canals, and water-control structures.

The uppermost part of the surficial aquifer system (to a depth of 50 ft below land surface) is primarily composed of unconsolidated sand and marl with localized lenses of shell and shelly limestone. Organic sand, silt, and marl compose semiconfining layers from land surface to a depth of about 40 ft. A clayey marl unit, about 4- to 10-ft thick, is present from about 4 to 10 ft below land surface through the northern Midlands. Below the marl unit lies another semiconfining layer of muddy, organic sand. A semiconfining section of sediments consisting of fine sand and shallow marl layers tends to retard infiltration of rainfall, thereby reducing the rate of recharge to the surficial aquifer system (Miller, 1991, p. 8). Lithologic logs of two shallow wells (PB-1522 and PB-1524) and one deep well (PB-1552) in the District are presented in tables 1, 2, and 3, respectively. Well PB-1552 was logged to a depth of 170 ft, but was backfilled and completed to a depth of 100 ft.

The unconfined surficial aquifer system exists under water-table conditions, with water levels increasing in the wet season (June-October) and decreasing during the dry season (November-May). Water-level changes are caused primarily by surface-water recharge, precipitation, domestic and industrial pumping, and losses due to evapotranspiration. Groundwater and surface-water exchange, which can affect water quality, occurs in the surficial aquifer system depending on the relation of the water table to canal stages. The altitude of the water table in the South Indian River Water Control District is depicted in figure 3. West of the C-14 and C-18 canals, ground-water flow is in an easterly direction as shown by the widely spaced contours, which indicate a relatively flat water table. In the area north of the District, the contours follow the Northwest Fork of the Loxahatchee River in an east-northeasterly direction.

Previous Investigations

The U.S. Geological Survey has conducted several water-resources investigations in Palm Beach County. Rodis and Land (1976) evaluated the shallow aquifer as a prime freshwater resource for Palm Beach County. Miller and Lietz (1976) summarized water-quality data for Palm Beach County. Fisher (1980) evaluated a cavity-riddled zone of the surficial aquifer near Riviera Beach. Swayze and Miller (1984) described the hydrogeology of a zone of secondary permeability in the surficial aquifer system, and Miller (1988) described and evaluated the effects of urban and agricultural development on the surficial aquifer system. Miller (1991) also studied the hydrogeology and migration of septic tank effluent in the surficial aquifer system in the northern Midlands.

Acknowledgments

The author wishes to thank Ms. Gail Romero of the U.S. Geological Survey in Stuart, Fla., who collected most of the data and assisted in the preparation of this report. Thanks are also extended to Mr. Gale English, General Manager of the South Indian River Water Control District, for providing historical information about the District and to Mr. Lennart Lindahl, P.E., for providing input on a map of the District.

SAMPLING PROGRAM AND ANALYTICAL METHODS

The sampling program for this study began in July 1989 with the selection of 11 ground-water wells (table 4), ranging in depth from 19 to 118 ft, and 14 surface-water sites (table 5) which provided representative areal coverage of the South Indian River Water Control District (fig. 2). Water samples were collected from 1989 to 1994 to determine concentrations of major inorganic constituents and physical characteristics, trace metals, nitrogen and phosphorus species, and synthetic organic compounds. Dates of sampling for selected ground-water wells and surface-water sites used to analyze water-quality constituents in the District are presented in appendixes I and II.

Prior to sampling, wells were evacuated by a centrifugal pump, removing at least three volumes of casing water to ensure collecting water representative of the aquifer. A peristaltic pump with Tygon tubing was then used to collect water samples for inorganic analysis, thus preventing degasification due to agitation by a centrifugal pump. Water samples for organic analysis were collected by means of a Teflon bailer; the bailer was rinsed with methanol and organic-free water between sites to prevent cross contamination. Surface-water samples were collected for inorganic analysis using two methods: the equal-width-increment (EWI) method or the grab sample method. The EWI method involves the raising and lowering of a weighted bottle at a constant transit rate within one or more verticals in the cross section, so that the bottle is not completely

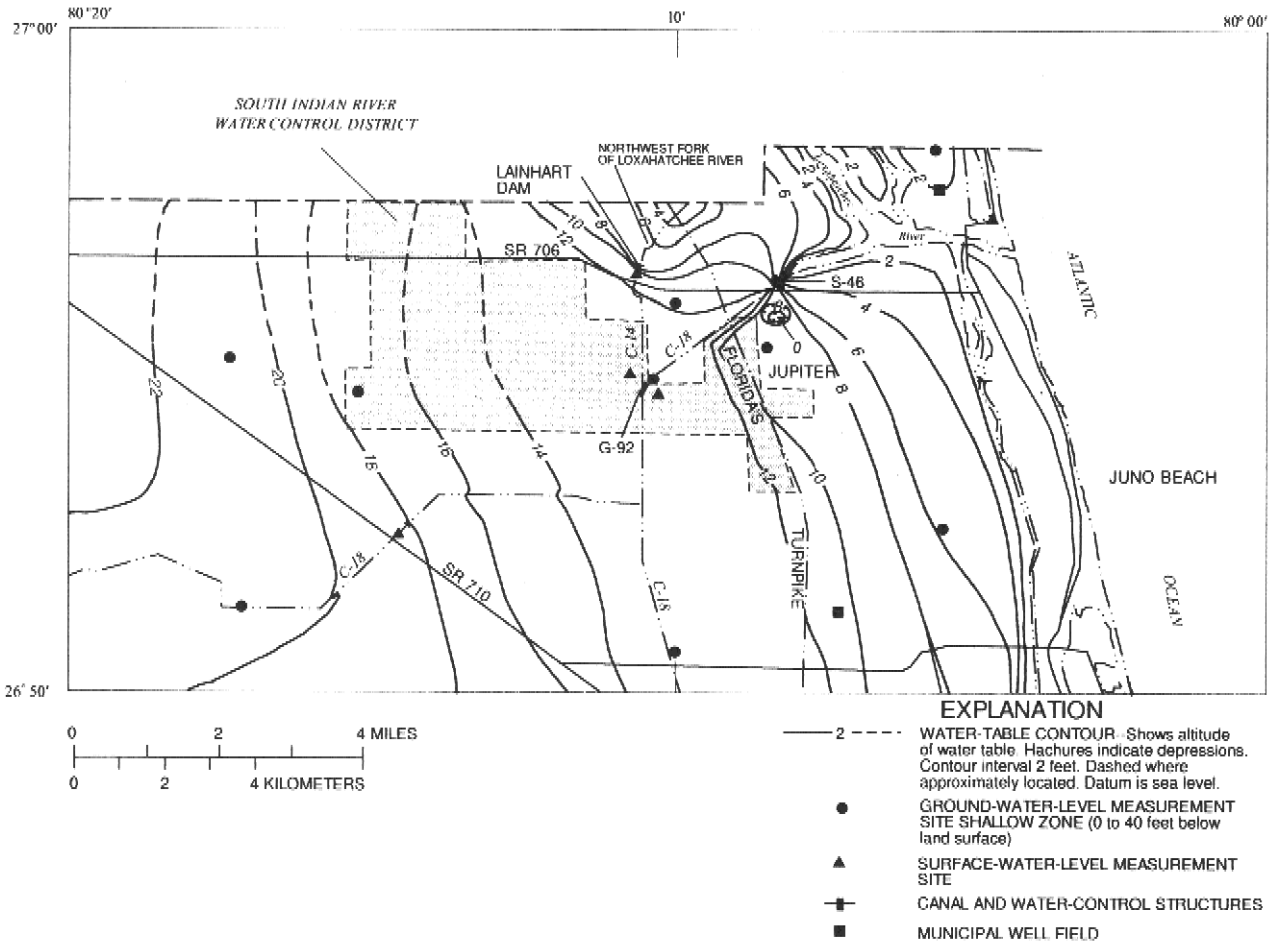


Figure 3. Water-table contours for the period of October 24-26, 1988. Ground-water flow direction is easterly in the South Indian River Water Control District (modified from Kane, 1992). Water table near canals may vary depending on hydrologic conditions.

Table 1. Lithologic log of well PB-1522

[Latitude 265417, longitude 801303 - Section 14, Township 41S, Range 41E]

Thickness (feet)	Depth, in feet below land surface	Description
5	0 - 5	Sand, light-brown to dark-brown; quartzose, fine to very fine; 5 to 10 percent heavy minerals; 5 percent shell fragments.
5	5 - 10	Sand, light-gray; quartzose, fine to very fine; 1 to 3 percent heavy minerals; 40 percent shell fragments, bivalves, gastropods, bryozoans; interbedded with limestone rock fragments; marl at 10 feet.
5	10 - 15	Sand, light-gray to medium-gray; quartzose, fine to very fine; 10 to 15 percent heavy minerals; about 15 percent shell fragments; 10 percent marl.
5	15 - 20	Sand, brownish-gray; quartzose, fine to very fine; 5 to 10 percent heavy minerals; black organics; 5 to 10 percent silt-size particles.
2	20 - 22	Sand, as in 15 to 20 feet.

Table 2. Lithologic log of well PB-1524

[Latitude 265443, longitude 801520 - Section 16, Township 41S, Range 41E

Thickness (feet)	Depth, in feet below land surface	Description
5	0 - 5	Sand, brownish-gray; quartzose, fine to very fine, well sorted; 3 to 5 percent heavy minerals.
5	5 - 10	Sand, brownish-gray to dark-brown; as noted; 5 to 10 percent heavy minerals; abundant organics; marl layers.
5	10 - 15	Sand, grayish-green; quartzose, very fine; 3 to 5 percent heavy minerals; 15 to 20 percent shell fragments.
5	15 - 20	Sand, light-gray; as in 10 to 15 feet.

Table 3. Lithologic log of well PB-1552

[Latitude 265443, Longitude 801520 - Section 16, Township 41S, Range 41E]

Thickness (feet)	Depth, in feet below land surface	Description
3	0 - 3	Road fill.
2	3 - 5	Sand, dusky-brown (5 YR 2/2); quartzose, medium to very fine, moderately sorted, subangular to subrounded; about 1 percent carbonates; 20 to 25 percent organic mud, clay and silt size.
5	5 - 10	Sand, dark-yellowish-brown (10 YR 4/2); quartzose as above; 20 to 25 percent micritic mud; about 3 to 5 percent organic fragments; 5 to 10 percent detrital carbonates and shell fragments; *Chione, Tellina.*
14	10 - 24	Sand, dark-yellowish-brown (10 YR 4/2); quartzose, medium to very fine, moderately sorted, subrounded to rounded; about 1 percent heavy minerals, fine to very fine, subrounded to rounded; about 1 percent detrital carbonates; about 5 to 10 percent mud, clay and silt size.
3	24 - 27	Sand, light-olive-gray (5 Y 5/2); as above; 1 to 3 percent mud, clay and silt size.
3	27 - 30	Sand, as above.
4	30 - 34	Sand, light-gray (N 7) to yellowish-gray (5 Y 7/2); quartzose, medium to very fine, moderately sorted, subangular to subrounded; 1 to 3 percent heavy minerals, fine to very fine, moderately sorted, subangular to rounded; 3 to 5 percent detrital carbonates and shell fragments. *Chione, Cardita,* other bivalves.
3	34 - 37	Sand, light-gray (N 7) to yellowish-gray (5 Y 8/1); quartzose, medium to very fine, moderately sorted, angular to subrounded; 1 to 3 percent heavy minerals as above; 30 to 35 percent detrital carbonates and shell fragments. *Chione, Ostrea, Cardita, Limopsis, Donax, Cerithium, Crepidula, Prunum, Olivella, Philippia, Chlamys.*
3	37 - 40	Sand, light-olive-gray (5 Y 6/1) to yellowish-gray (5 Y 8/1); as above; 3 to 5 percent heavy minerals.
4	40 - 44	Sand; as above; about 1 to 3 percent rock fragments.
3	44 - 47	Sand; as above; 35 to 40 percent detrital carbonates and shell fragments, *Busycon.*
7	47 - 54	Sand, olive-gray (5 Y 4/1); quartzose, medium to very fine, moderately sorted, angular to subrounded; 5 to 10 percent heavy minerals and phosphates, fine to very fine, moderately sorted, subangular to rounded; 30 to 35 percent detrital carbonates and shell fragments.
3	54 - 57	Sand, olive-gray (5 Y 4/1); quartzose, fine to very fine, well sorted, subangular to subrounded; 5 to 10 percent heavy minerals and phosphates, fine to very fine, well sorted, subangular to rounded; 35 to 40 percent detrital carbonates and shell fragments.
3	57 - 60	Sand; as above; interbedded with 10 percent limestone and claystone, light-olive-gray (5 Y 5/2); micrite and clay.
4	60 - 64	Sand, olive-gray (5 Y 4/1); quartzose, fine to very fine, well sorted, angular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, well sorted, subangular to rounded; 35 to 40 percent detrital carbonates and shell fragments.
6	64 - 70	Sand, light-olive-gray (5 Y 5/2); as above.
4	70 - 74	Sand, light-olive-gray (5 Y 6/1); as above; quartzose, medium to very fine, angular to subrounded.
3	74 - 77	Sand, light-olive-gray (5 Y 6/1); quartzose, fine to very fine, well sorted, angular to subrounded; 5 to 10 percent heavy minerals and phosphates, fine to very fine, well sorted, subangular to rounded; 1 to 3 percent micrite; 35 to 40 percent detrital carbonates and shell fragments.
3	77 - 80	Sand, olive-gray (5 Y 4/1); detrital carbonates and shell fragments; 25 to 30 percent quartzose, very fine, well sorted, angular to subrounded; 5 to 10 percent heavy minerals and phosphates, fine to very fine, well sorted, subangular to rounded; about 5 percent micrite.
4	80 - 84	Sand, light-olive-gray (5 Y 6/1); as above.
6	84 - 90	Sand, light-olive-gray (5 Y 6/1); quartzose, fine to very fine, well sorted, angular to subrounded; 5 to 10 percent heavy minerals and phosphate as above; 35 to 40 percent detrital carbonates and shell fragments, *Terebra.*
7	90 - 97	Sand, olive-gray (5 Y 4/1); quartzose, fine to very fine, angular to subrounded, well sorted; 5 to 10 percent heavy minerals and phosphates, fine to very fine, moderately sorted, subrounded to rounded; 35 to 40 percent detrital carbonates and shell fragments.

Table 3. Lithologic log of well PB-1552--Continued

Thickness (feet)	Depth, in feet below land surface	Description
3	97 - 100	Sand, olive-gray (5 Y 4/1) to medium-dark-gray (N 4); quartzose, medium to very fine, moderately sorted, angular to subrounded; 3 to 5 percent heavy minerals, fine to very fine, well sorted, subrounded to rounded; 20 to 25 percent detrital carbonates and phosphates, very coarse to very fine; 20 to 25 percent shells and shell fragments, *Turritella*, *Chione*, echinoid plates, *Crucibulum*, *Tellina*, *Anadora*.
4	100 - 104	Sand, olive-gray (5 Y 4/1); as above; interbedded with about 20 percent fossiliferous limestone, light-olive-gray (5 Y 6/1), packed biosparite, bivalves; 15 to 20 percent quartz, medium to very fine, subangular to subrounded; poorly cemented; very porous.
3	104 - 107	Sand, light-olive-gray (5 Y 6/1); quartzose, medium to very fine, moderately sorted, subangular to subrounded; 5 to 10 percent heavy minerals and phosphates, medium to very fine, moderately sorted, subrounded to rounded; 35 to 40 percent detrital carbonates and shell fragments; interbedded with about 10 percent limestone, packed biosparite; 20 percent quartz, medium to very fine, subangular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, subrounded to rounded; poorly cemented; very porous.
3	107 - 110	Sand, interbedded with about 10 percent limestone as above.
4	110 - 114	Sand, light-olive gray (5 Y 6/1); quartzose, fine to very fine, well sorted, subangular to subrounded; 5 to 10 percent heavy minerals and phosphates, fine to very fine, well sorted, subrounded to rounded; 30 to 35 percent detrital carbonates and shell fragments; lost circulation at 113 feet.
3	114 - 117	Marl, yellowish-gray (5 Y 8/1); clay and micrite; impermeable.
3	117 - 120	Sand, light-olive-gray (5 Y 6/1); quartzose, medium to very fine, moderately sorted, angular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, well sorted, subangular to subrounded; 25 to 30 percent detrital carbonates and shell fragments, abundant bivalve fragments; interbedded with about 20 percent marl as above.
4	120 - 124	Sand, yellowish-gray (5 Y 8/1); detrital carbonates and shell fragments, bivalve fragments; 35 to 40 percent quartzose, fine to very fine, well sorted, angular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, well sorted, subrounded to rounded; interbedded with about 10 percent limestone, packed biosparite; 10 percent quartz, fine to very fine, subangular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, subrounded to rounded; poorly cemented; very porous, moldic.
3	124 - 127	Sand; as above; quartzose, medium to very fine, moderately sorted, angular to subrounded; interbedded with 20 percent limestone, light-olive-gray (5 Y 6/1); sandy, sparse biosparite; 20 to 25 percent quartz, medium to very fine, subangular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, subrounded to rounded; poorly cemented; very porous, moldic.
7	127 - 134	Sand, very light gray (N 8) to yellowish-gray (5 Y 8/1); quartzose, medium to silt size, moderately sorted, angular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, well sorted, subrounded to rounded; 15 to 20 percent detrital carbonates and shell fragments.
6	134 - 140	Sand, very light gray (N 8) to yellowish-gray (5 Y 8/1); quartzose, fine to very fine, well sorted, subangular to subrounded; 1 to 3 percent detrital carbonates, coarse to very fine; 1 to 3 percent heavy minerals and phosphates, fine to very fine, well sorted, subrounded to rounded; 5 to 10 percent sandstone nodules, micritic matrix; very poorly cemented.
4	140 - 144	Sand as above; quartzose, medium to very fine.
6	144 - 150	Clayey sand, light-olive-gray (5 Y 5/2); quartzose, fine to very fine, well sorted, subangular to subrounded; 3 to 5 percent heavy minerals and phosphates as above; 1 to 3 percent detrital carbonates; 15 to 20 percent marl, micritic, clay and silt.
4	150 - 154	Sand as above; 20 to 25 percent clay and silt.
3	154 - 157	Clayey sand, light-olive-gray (5 Y 5/2), quartzose, fine to very fine, well sorted, angular to subrounded; 3 to 5 percent heavy minerals and phosphates, fine to very fine, well sorted, subrounded to rounded; 1 to 3 percent detrital carbonates; 25 to 30 percent clay and silt.
3	157 - 160	Sandy clay, grayish-olive (10 Y 4/2); clay and silt; 35 to 40 percent quartzose as above; 3 to 5 percent heavy minerals and phosphates as above; 1 to 3 percent detrital carbonates.
4	160 - 164	Sandy clay, pale-olive (10 Y 7/2) to light-olive-gray (5 Y 5/2); clay and silt; 30 to 35 percent quartzose as above; 5 to 10 percent heavy minerals and phosphates as above; 3 to 5 percent detrital carbonates.
6	164 - 170	Sandy clay, light-olive-gray (5 Y 5/2); as above.

Table 4. Description of ground-water wells used to study water quality in the South Indian River Water Control District

[PVC, polyvinyl chloride; --, unknown]

Well number	U.S. Geological Survey site identification number	Well depth (feet)	Top of casing (feet)	Bottom of casing (feet)	Casing material	Diameter of casing (inches)	Screened interval (feet)
PB-711	265510080083401	23	0.0	21.0	Black iron	2.0	2
PB-875	265439080102904	24	0.0	20.0	PVC	2.0	--
PB-880	265439080102901	118	0.0	90.0	PVC	4.0	28
PB-928	265508080083301	115	0.0	115.0	Black iron	2.5	--
PB-1520	265412080092701	23	0.5	20.5	PVC	2.0	2
PB-1522	265417080130301	23	0.5	20.5	PVC	2.0	2
PB-1524	265443080152001	19	0.0	17.0	PVC	2.0	2
PB-1552	265443080152002	100	0.0	90.0	PVC	2.0	10
PB-1651	265418080082901	29	0.0	26.1	PVC	2.0	3
PB-1652	265418080082902	74	0.0	70.9	PVC	2.0	3
PB-1653	265537080123001	23	0.0	19.6	PVC	2.0	3

Table 5. U.S. Geological Survey site identification numbers, latitudes, and longitudes for selected surface-water sites used to study water quality in the South Indian River Water Control District

Site number	U.S. Geological Survey site identification number	Latitude (degrees)	Longitude (degrees)
SW-1	265613080100700	265613	0801007
SW-2	265631080132500	265631	0801325
SW-3	265538080135500	265538	0801355
SW-4	265352080120400	265352	0801204
SW-5	265513080103300	265513	0801033
SW-6	265437080103200	265437	0801032
SW-7	265415080093900	265415	0800939
SW-8	265439080084000	265439	0800840
SW-9	265537080090200	265537	0800902
SW-10	265552080085000	265552	0800850
SW-20	265558080105100	265558	0801051
SW-21	02277480	265537	0801131
SW-22	265417080082200	265417	0800822
SW-23	265632080144200	265632	0801442

full when returned to the surface. The grab sample method entails filling the sample bottle at a single depth and location. The grab sample method was used at most sites because most of the surface-water sites do not have bridges, and EWI sampling was considered impractical.

Surface-water samples collected for determination of major inorganic constituents and physical characteristics, trace metals, and nitrogen and phosphorus species were composited in a churn splitter before processing for laboratory analysis. Surface-water samples for organic determinations were collected directly from the stream in weighted 1-liter glass bottles using a basket sampler. Temperature, pH, dissolved oxygen, and specific conductance were measured in the field at the time of ground-water and surface-water sampling. Water samples collected for determination of nitrogen and phosphorus species and organic compounds were chilled to 4 degrees Celsius and shipped within 24 hours for laboratory analysis. All water samples requiring preservatives to inhibit sample degradation were treated in the field at the time of collection.

Major inorganic constituents, trace metals, and nitrogen and phosphorus species were analyzed at the U.S. Geological Survey Water Quality Service Unit in Ocala, Fla., according to procedures described by Fishman and Friedman (1989). Synthetic organic compounds (acid-extractable compounds, base/neutral-extractable compounds, pesticides, and volatile organic compounds) were analyzed at the U.S. Geological Survey National Water Quality Laboratory in Arvada, Colo., according to U.S. Geological Survey protocol as described by Wershaw and others (1983). The GC/FID scan analyses, used for semiquantitative synthetic organic compound detection, were determined at the U.S. Geological Survey Water Quality Service Unit in Ocala, according to the same procedures. Quality assurance procedures (Florida Department of Environmental Protection, 1993a) included field and equipment blanks both analyzed at the Ocala and Arvada laboratories. Data were stored in WATSTORE, the U.S. Geological Survey's national computer data base.

ASSESSMENT OF WATER QUALITY

The quality of ground water and surface water can be described in terms of their chemical constituents and physical and biological characteristics. The Florida Department of Environmental Protection (1993a and 1993b) has classified the waters of the State for specific categories of use and has set standards for these uses. Water is considered poor quality or contaminated if a particular constituent exceeds the primary maximum contaminant levels (PMCL's) or secondary maximum contaminant levels (SMCL's) for drinking-water established by the Florida Department of Environmental Protection (1993b). The contamination can be a health hazard or an esthetic degradation.

Various chemical constituents and physical characteristics were monitored in the South Indian River Water Control District to assess its water quality. These constituents and characteristics are summarized in the subsequent sections of this report. Statistical summaries of selected ground-water and surface-water quality data (1989-94) are presented in appendixes III and IV.

Major Inorganic Constituents and Physical Characteristics

From July 1989 to August 1994, ground-water and surface-water samples were collected at selected sites in the South Indian River Water Control District (fig. 2) for determination of major inorganic constituents, hardness, dissolved solids, color, temperature, specific conductance, and pH. Major inorganic chemistry and related data were used as a general indicator of water quality and to: (1) identify some of the physical-chemical processes that affect the composition of natural waters, and (2) assess which constituents exceed the State of Florida PMCL's or SMCL's.

Eleven ground-water wells and eight surface-water sites were sampled monthly for major inorganic constituents beginning in 1989 (app. I and II). Six additional surface-water sites were sampled monthly at various times between 1990 and 1994 (app. II). The sampling schedule for major inorganic constituents at most of the ground-water wells and surface-water sites was changed to a quarterly basis beginning in the 1993 water year and semiannually beginning in the 1994 water year. The sampling of chemical oxygen demand was conducted twice in 1993 at selected ground-water wells and surface-water sites (app. I and II).

Water Types

Major inorganic constituents, as discussed in this report, include those cations (positively charged ions) and anions (negatively charged ions) that constitute the bulk of the dissolved solids and include those constituents that commonly occur in concentrations exceeding

1.0 mg/L (milligram per liter). The major dissolved cations generally are calcium, magnesium, sodium, and potassium; the major anions are sulfate, chloride, fluoride, and those constituents contributing to alkalinity which primarily are carbonate and bicarbonate (Hem, 1985). These charged species in solution contribute to the water's specific conductance, defined as the ability to conduct an electric current. Both dissolved solids and specific conductance are dependent on the degree of mineralization of the water and are indicators of general inorganic water quality. Silicon, which is nonionic, contributes to the dissolved solids and is usually reported as silica.

The chemical compositions of ground water and surface water in the South Indian River Water Control District are shown in the trilinear diagrams (figs. 4-10). Selected cations and anions for each individual analysis were plotted on triangles as a percentage of total cations and anions in millicquivalents per liter. These plots, projected on a diamond-shaped field, can be used (based on their position) to illustrate chemically similar water types or identify waters that are mixtures of two different types. Water types are based on which cations or anions dominate (50 percent or greater). For example, a water type in which calcium is the dominant cation and bicarbonate is the dominant anion is referred to as calcium bicarbonate type water. A mixed-ion type water is one in which no cation or anion dominates (Maddy and others, 1992). The trilinear diagrams for the ground-water analyses (figs. 4-6) show that the predominant water type in the South Indian River Water Control District, except at wells PB-1524 and PB-1552 (fig. 5), is calcium bicarbonate, which is due to the dissolution of limestone from the surficial aquifer system.

Water from several wells occasionally departed from the typical calcium bicarbonate type water and depicted a mixed-ion type water. This mixed-ion type water is apparent at wells PB-711 and PB-880 (fig. 4) and wells PB-1651 and PB-1652 (fig. 6). Several analyses from well PB-880 (fig. 4) demonstrated mixed-cation type water in which neither calcium, magnesium, sodium, nor potassium were dominant (greater than 50 percent). A few analyses from wells PB-711 (fig. 4), PB-1651 (fig. 6), and PB-1652 (fig. 6) demonstrated mixed-anion type water in which neither chloride, sulfate, nor bicarbonate were dominant. Well PB-1653 (fig. 6) depicted both calcium bicarbonate and sodium bicarbonate type waters, indicating ion exchange of sodium for calcium had occurred and resulting in natural softening. Well PB-1653 also demonstrated mixed-cation type water in which neither calcium, magnesium, sodium, nor potassium were dominant. This variation in water types from the same sites might be due to mixing of different waters during different seasons. Magnesium in the absence of seawater occurs in small quantities in southern Florida ground water and is due to dissolution of dolomitic limestone. The presence of sulfate might be due to oxidation of hydrogen sulfide from organic deposits in the surficial aquifer system.

Sodium chloride type water was detected at wells PB-1524 and PB-1552 (fig. 5). This water type is the result of incomplete flushing of residual seawater emplaced during the Pleistocene Epoch. Much of the northern Midlands is affected by residual seawater (Miller, 1991, p. 12). According to Miller, highly mineralized sodium chloride type water exists in both shallow and deep zones of the surficial aquifer system in western areas of the South Indian River Water Control District, rendering the water unsuitable as a potable supply.

Trilinear diagrams from all surface-water sites (figs. 7-10) depict calcium bicarbonate type water. One analysis at site SW-2 (fig. 7) exhibited a mixed-ion type water in which neither the cations nor the anions were dominant.

Summary of Major Inorganic Data

Water hardness is reported as an equivalent amount of calcium carbonate ($CaCO_3$) and is dependent primarily on calcium and magnesium. Limestone present in the surficial aquifer system is a natural source of hardness. There are no Federal or State standards for hardness; hardness generally is classified (Hem, 1985, p. 159) as follows: soft (0-60 mg/L), moderately hard (61-120 mg/L), hard (121-180 mg/L), and very hard (greater than 180 mg/L). In the South Indian River Water Control District, water is classified as moderately hard in 5 percent of ground-water analyses and 15 percent of surface-water analyses, hard in 9 percent of ground-water analyses and 30 percent of surface-water analyses, and very hard in 86 percent of ground-water analyses and 55 percent of surface-water analyses. There are no ground-water or surface-water analyses classified as soft in the District.

Four major inorganic constituents and physical characteristics exceeded the drinking-water standards (PMCL's or SMCL's) in some ground-water and surface-water samples. These four constituents and characteristics (sodium, chloride, dissolved solids, and

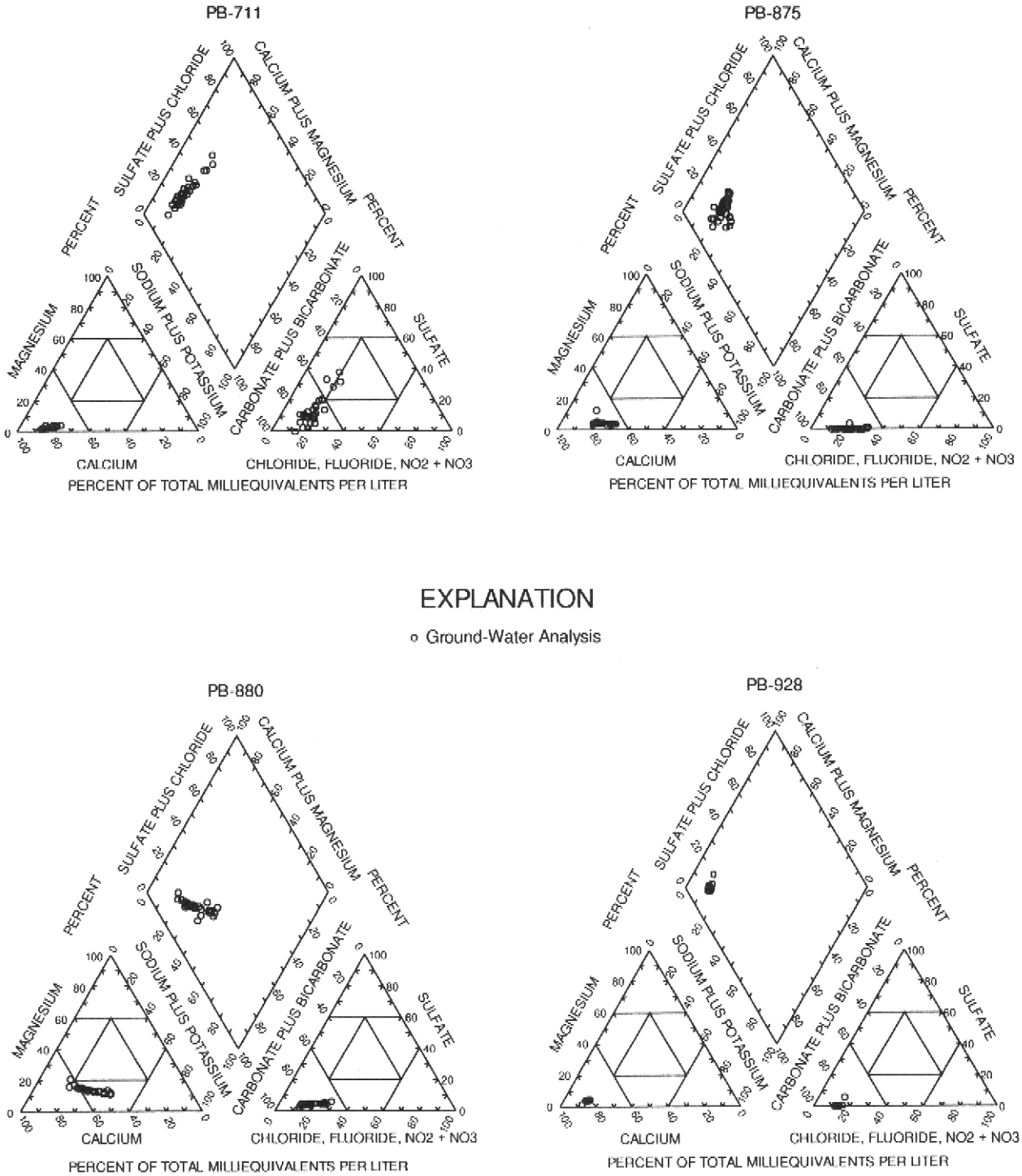


Figure 4. Chemical composition of ground-water samples collected from wells PB-711, PB-875, PB-880, and PB-928.

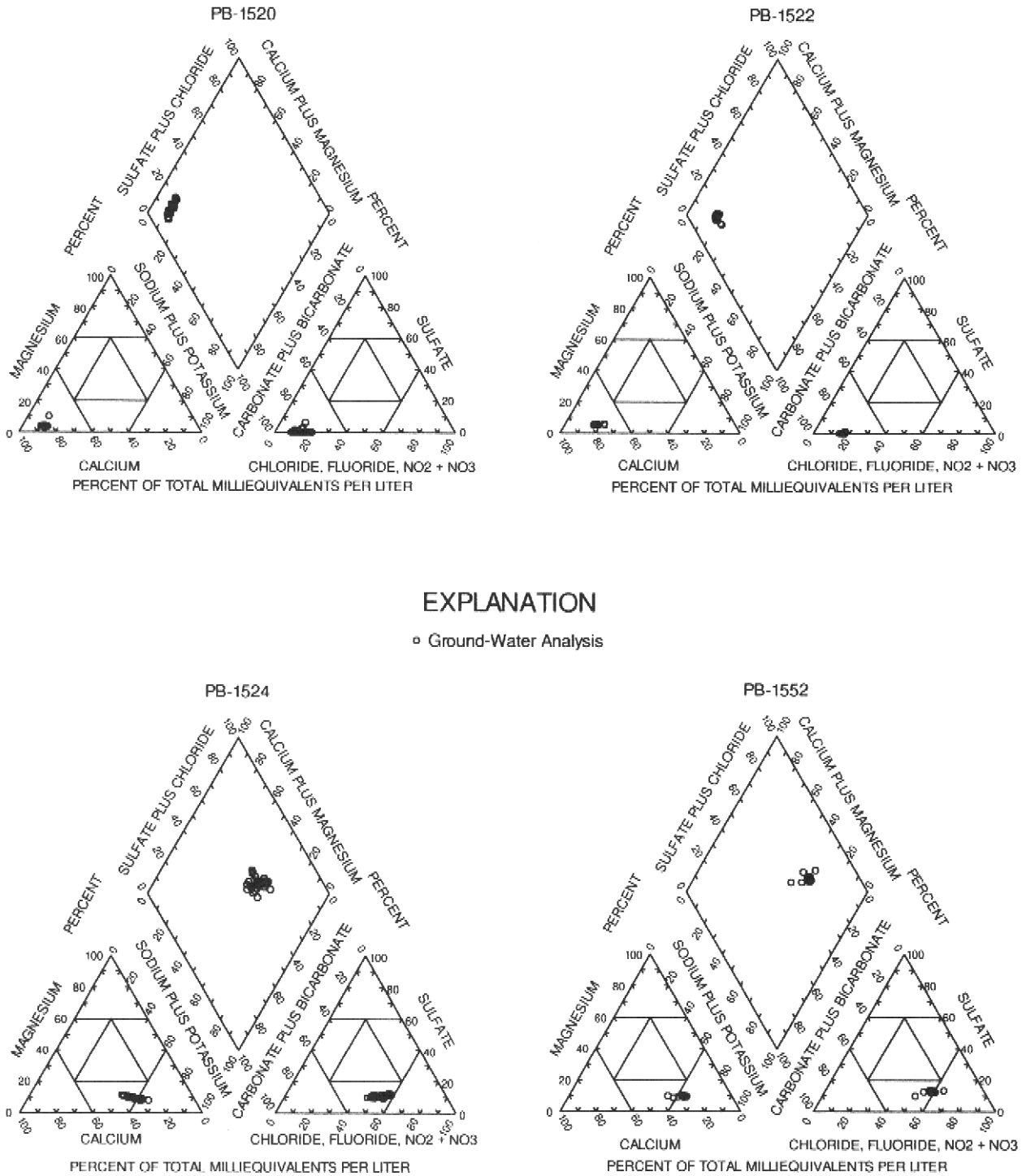


Figure 5. Chemical composition of ground-water samples collected from wells PB-1520, PB-1522, PB-1524, and PB-1552.

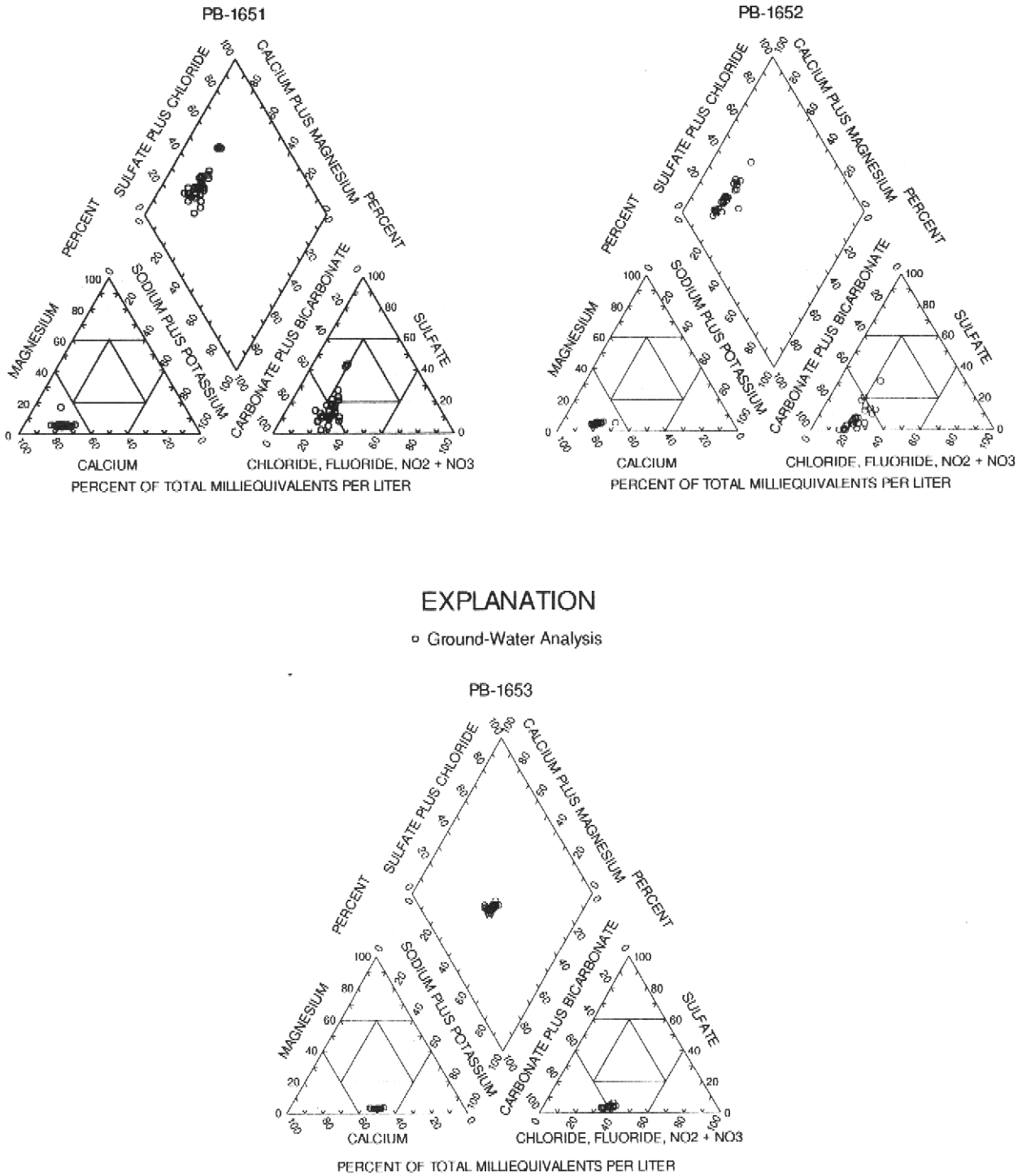
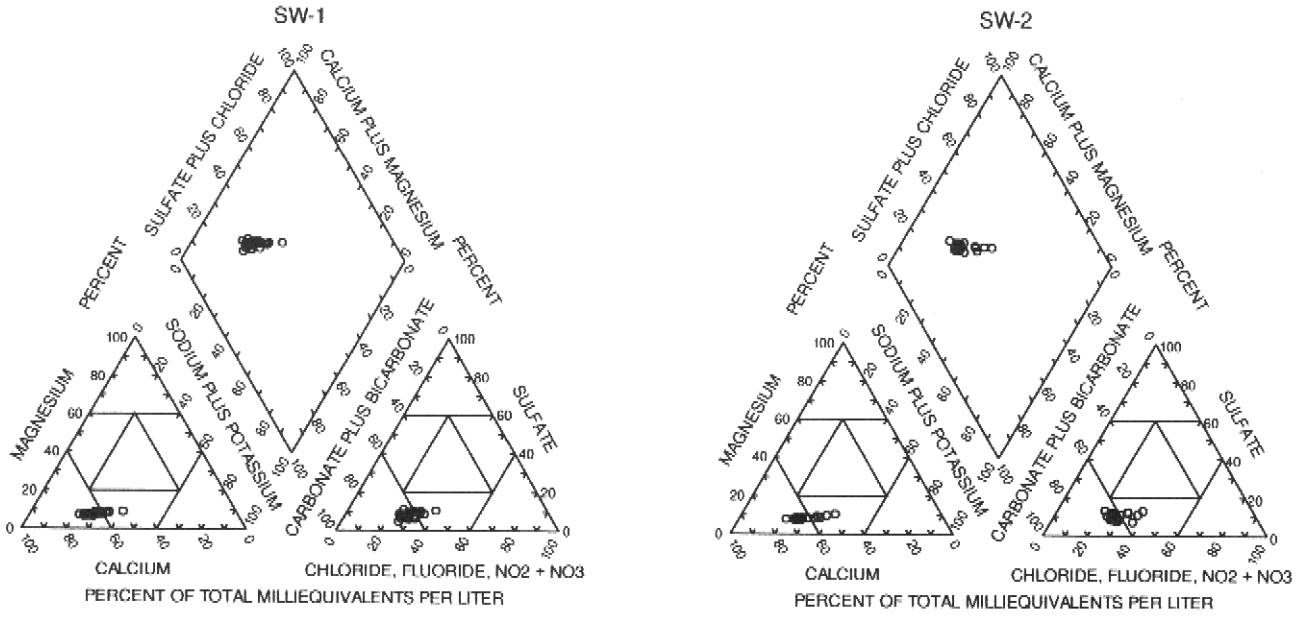


Figure 6. Chemical composition of ground-water samples collected from wells PB-1651, PB-1652, and PB-1653.



EXPLANATION

▫ Surface-Water Analysis

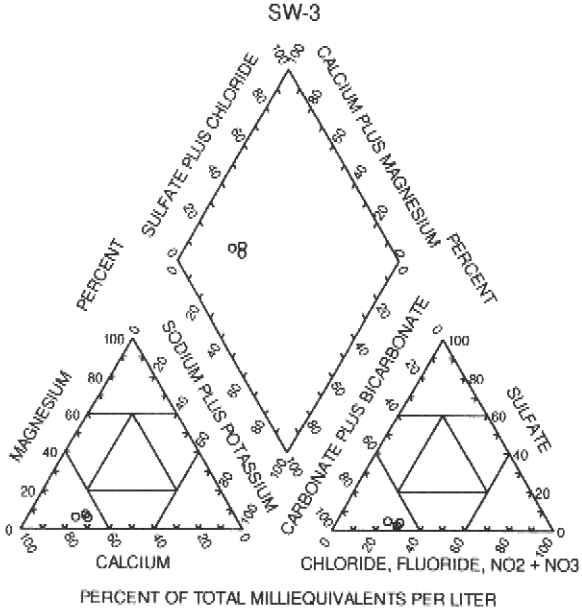


Figure 7. Chemical composition of surface-water samples collected from sites SW-1, SW-2, and SW-3.

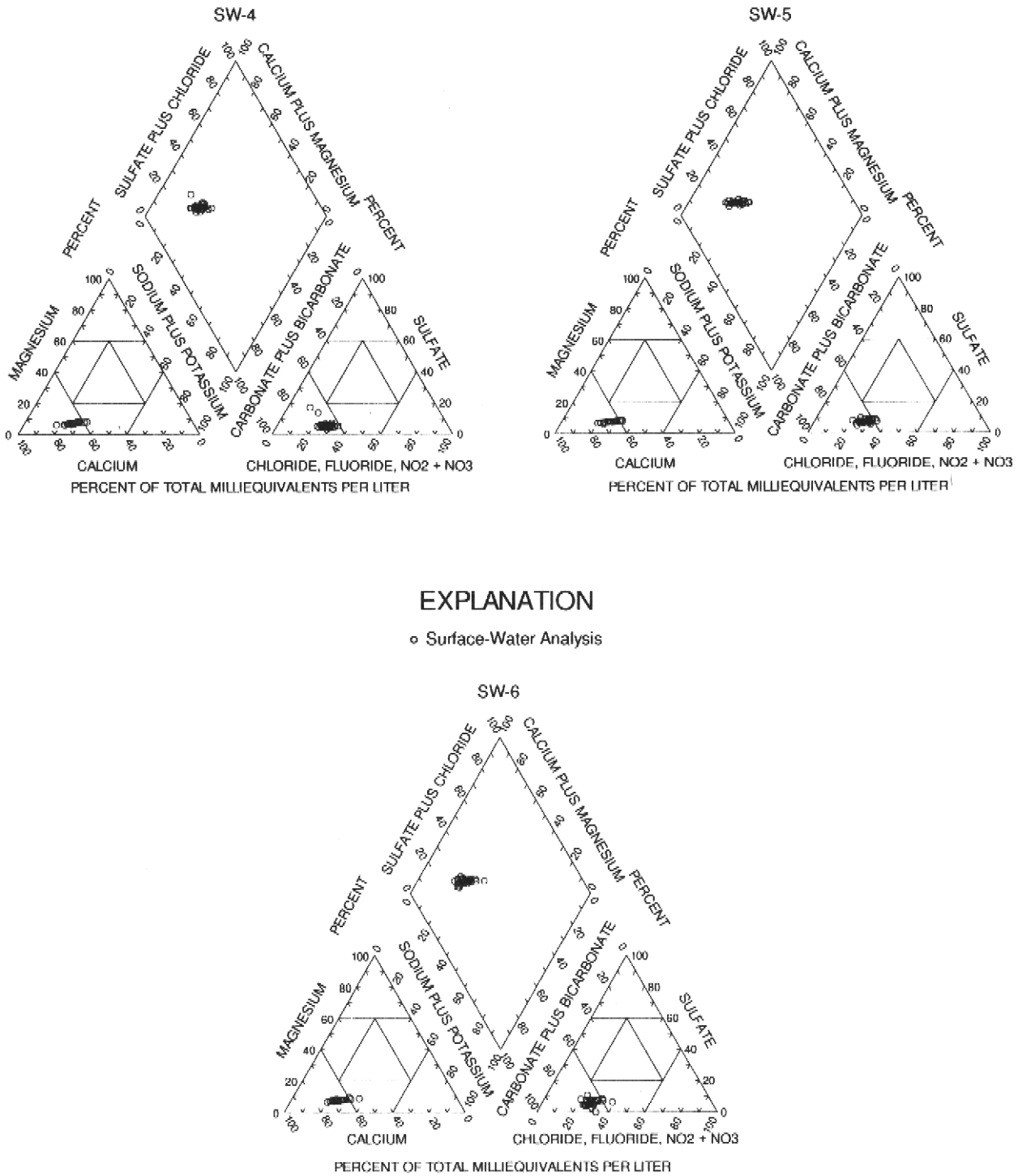


Figure 8. Chemical composition of surface-water samples collected from sites SW-4, SW-5, and SW-6.

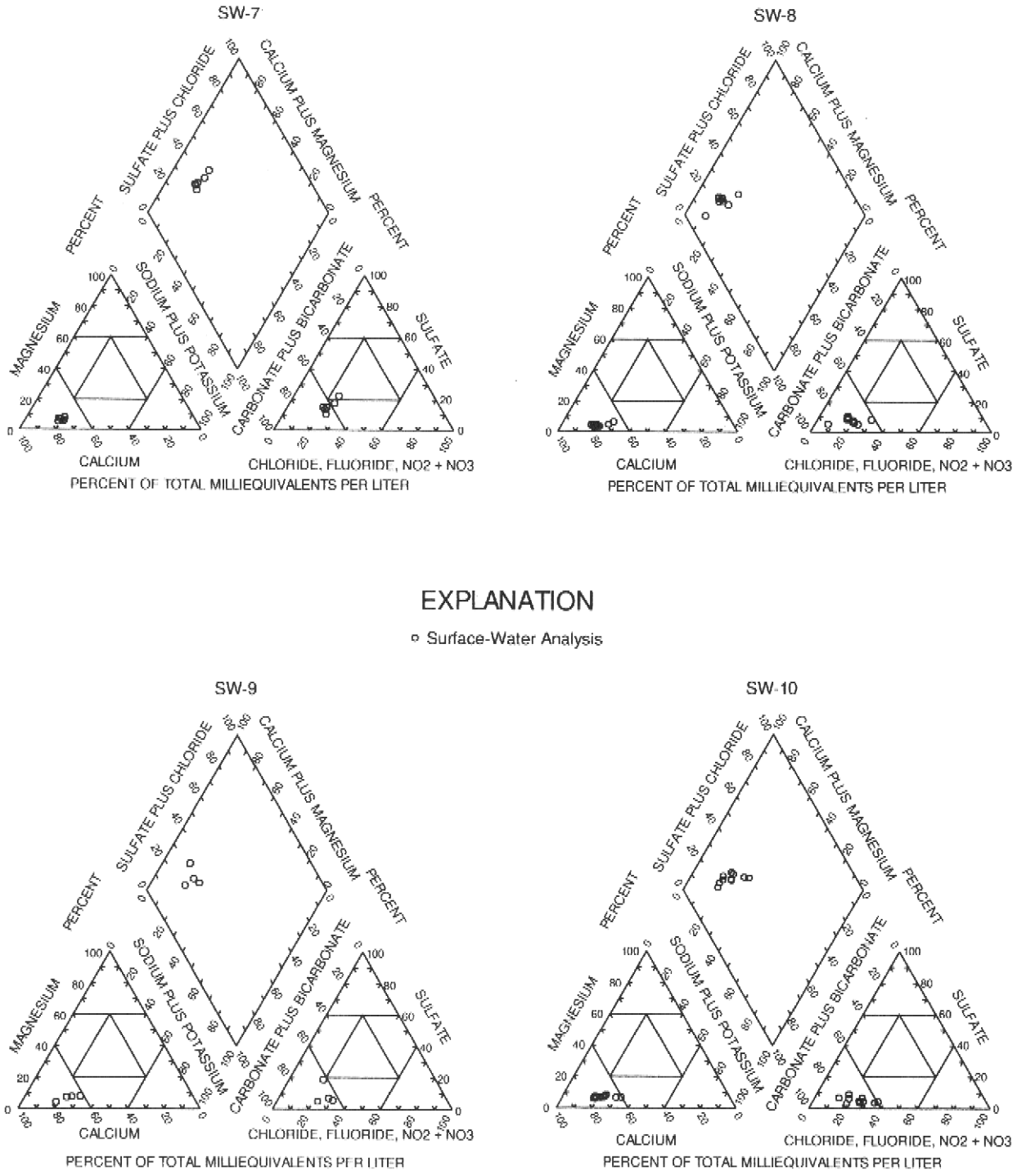
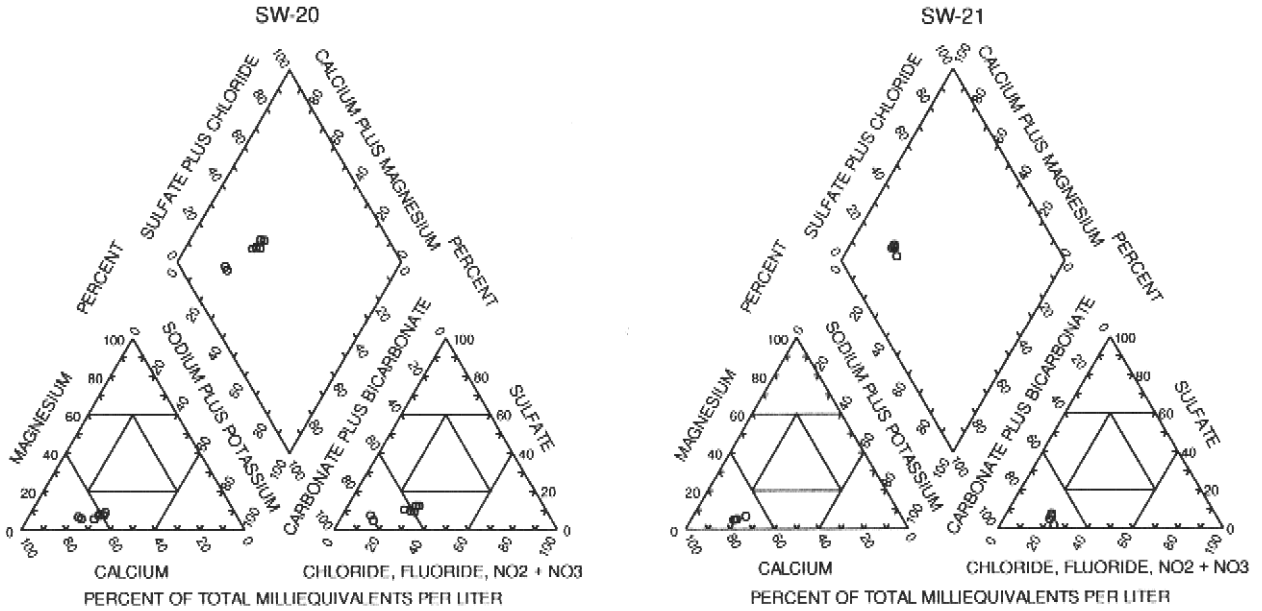


Figure 9. Chemical composition of surface-water samples collected from sites SW-7, SW-8, SW-9, and SW-10.



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o Surface-Water Analysis

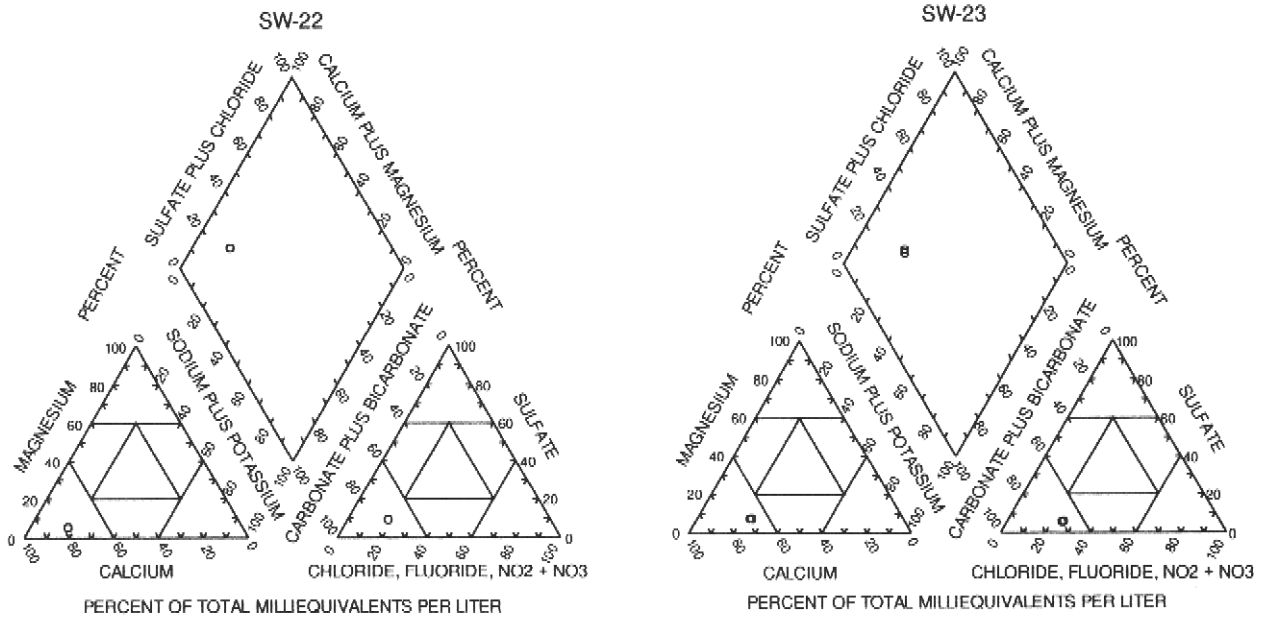


Figure 10. Chemical composition of surface-water samples collected from sites SW-20, SW-21, SW-22, and SW-23.

color) are summarized in table 6. Box plots showing the distribution of concentrations of chloride, dissolved solids, and sodium at ground-water wells and surface-water sites where water-quality standards were exceeded are depicted in figure 11. Box plots are graphical means of displaying the locality, spread, and skewness of a distribution. The top and bottom of the box represent the upper (75th percentile) and lower (25th percentile) quartiles of the data. Fifty percent of the data are contained within these limits. The median (50th percentile) is indicated by a horizontal line within the box. The lines extending outward from both ends of the box are called whiskers and represent the 1st and 99th percentiles of the data. Any data points less than or greater than these percentiles are referred to as outliers.

During 1989-94, ground-water samples had sodium concentrations ranging from about 8 to 440 mg/L, chloride concentrations ranging from 13 to 650 mg/L, and dissolved-solids concentrations ranging from 164 to 1,780 mg/L (table 7). The highest dissolved-solids concentration (detected in well PB-1552) indicates a high degree of mineralization. Color values ranged from 10 to 1,400 Pt-Co (platinum-cobalt) units (table 7), with virtually all ground-water samples collected from the 11 wells exceeding the SMCL (15 Pt-Co units). Organic material deposited in the surficial aquifer system might have contributed to the elevated color values. Concentrations of sodium exceeded the PMCL (160 mg/L) and concentrations of chloride exceeded the SMCL (250 mg/L) in water samples collected from wells PB-1524 and PB-1552 (fig. 11). Dissolved-solids concentrations exceeded the SMCL (500 mg/L) in water samples collected from wells PB-880, PB-1520, PB-1524, PB-1552, and PB-1653 (fig. 11).

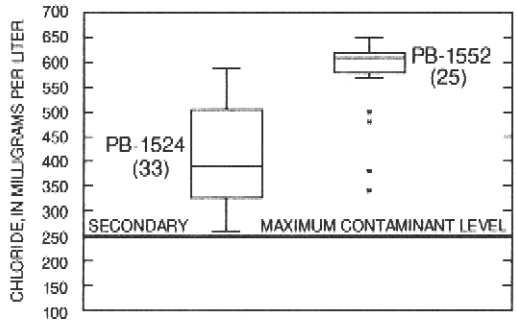
During 1989-94, surface-water samples had dissolved-solids concentrations ranging from 134 to 520 mg/L (table 7). The highest concentration at site SW-1 (fig. 11) exceeded the SMCL (500 mg/L); however, less than 1 percent of all surface-water samples collected from the 14 sites had dissolved-solids concentrations exceeding the SMCL. Color values ranged from 20 to 240 Pt-Co units (table 7), with all of the surface-water samples collected from the 14 sites exceeding the SMCL (15 Pt-Co units).

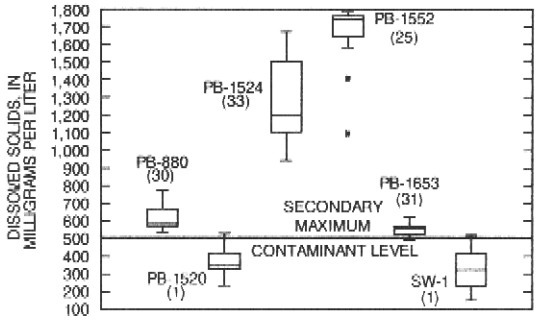
The chemical characteristic pH is defined as the negative base-10 logarithm of the hydrogen ion activity in moles per liter and is a measure of the acidity or alkalinity of the water. Values of pH ranged from 6.4 to 8.4 in ground water and from 6.6 to 8.5 in surface water (table 7). One pH value (6.4) at one well was outside of State limits (less than 6.5 or greater than 8.5). No pH value at surface-water sites were outside these limits. Most ground water in the United States has pH values that range from 6.0 to 8.5, and river waters range from 6.5 to 8.5 (Hem, 1985, p. 64).

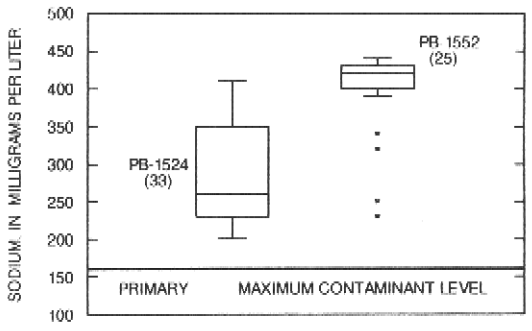
Table 6. Summary of major inorganic constituents and color exceeding the drinking-water standards in some ground-water and surface-water samples at selected sites

[Concentrations shown in milligrams per liter, except for color which is shown in platinum-cobalt units. FDEP standard represents the Florida Department of Environmental Protection (1993b) drinking-water regulations standard. <, less than the value]

Constituent	Number of samples	FDEP standard	Percent of samples exceeding standard	Wells or sites exceeding standard
Sodium	337	160	17	PB-1524, PB-1552
Chloride	343	250	17	PB-1524, PB-1552
Dissolved solids	338	500	36	PB-880, PB-1520, PB-1524, PB-1552, PB-1653
	194		<1	SW-1
Color	338	15	99	All ground-water wells
	194		100	All surface-water sites







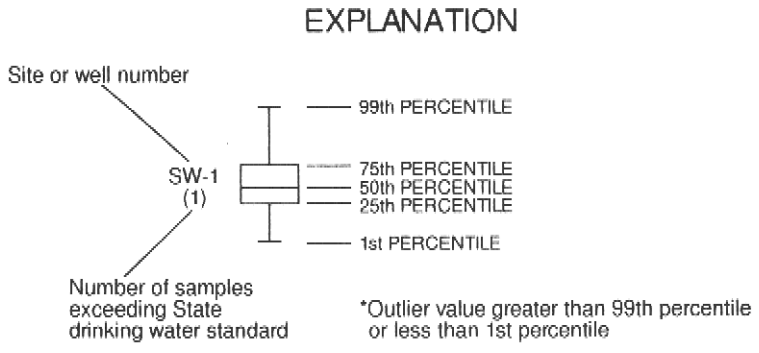


Figure 11. Distribution of concentrations of chloride, dissolved solids, and sodium at selected sites where water-quality standards were exceeded in the South Indian River Water Control District.

Table 7. Water-quality analysis of major inorganic constituents and physical characteristics in the South Indian River Water Control District, 1989-94

[Concentrations shown in milligrams per liter, except where indicated; FDEP standard represents the Florida Department of Environmental Protection (1993b) drinking-water regulations standard. NS, no standard exists for particular constituent; Pt-Co units, platinum-cobalt units; <, less than the value; >, greater than the value; --, no data]

Constituent or characteristic	FDEP standard	Type of maximum contaminant level	Ground-water samples					Surface-water samples				
			Number of samples	Maximum	Mean	Median	Minimum	Number of samples	Maximum	Mean	Median	Minimum
Calcium (Ca)	NS	None	338	170	99	93	36	194	100	67	69	25
Magnesium (Mg)	NS	None	338	37	9	3.8	0.6	194	10	4.5	4.7	1.2
Sodium (Na)	160	PMCL[1]	337	440	88	25	7.8	194	74	30	30	5.5
Potassium (K)	NS	None	338	21	3.3	0.84	0.2	194	5.3	1.6	1.5	0.1
Chloride (Cl)	250	SMCL[2]	343	650	121	41	13	194	100	48	49	8.9
Sulfate (SO_4)	250	SMCL[2]	338	190	36	16	<0.1	194	57	19	17	0.1
Fluoride (F)	4 2	PMCL[1] SMCL[2]	338	0.6	0.19	0.2	<0.1	194	1.0	0.17	0.2	<0.1
Dissolved solids	500	SMCL[2]	338	1,780	566	376	164	194	520	313	327	134
Hardness (as $CaCO_3$)	NS	None	338	570	285	250	95	194	280	186	190	70
Chemical oxygen demand	NS	None	21	110	41	36	17	15	49	39	39	26
Silica (SiO_2)	NS	None	338	32	15	17	10	194	23	8.9	8.3	2.3
Color (Pt-Co units)	15	SMCL[2]	338	1,400	94	60	10	194	240	66	50	20
pH (standard units)	<6.5 or >8.5	SMCL[2]	338	8.4	--	7.5	6.4	193	8.5	--	7.7	6.6

[1]Primary maximum contaminant level (PMCL): The maximum permissible level of a contaminant in water, which has a direct relation to human health.

[2]Secondary maximum contaminant level (SMCL): Contaminants that affect the esthetic quality of drinking water. At high concentrations or values, health implications as well as esthetic degradation can also exist.

Trace Metals

Trace metals can be cause for concern because, even in small amounts, some may be toxic to plants, animals, and humans. Determinations were made for trace metals including arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, strontium, and zinc. Trace-metal samples were collected at all 11 wells on a semiannual basis in 1993 and 1994 (app. I). Trace-metal samples also were collected at 10 surface-water sites on a semiannual basis, except at one site (SW-22) where only one sampling was made (app. II). Three trace metals exceeded the drinking-water standards (PMCL's or SMCL's) in some ground-water samples. These three constituents (cadmium, lead, and zinc) are summarized in table 8.

During 1989-94, ground-water samples had cadmium concentrations ranging from less than 1 to 12 µg/L (micrograms per liter), lead concentrations ranging from less than 1 to 39 µg/L, and zinc concentrations ranging from less than 4 to 14,000 µg/L (table 9). The highest concentration of cadmium exceeded the PMCL (5 µg/L) and the highest concentration of zinc exceeded the SMCL (5,000 µg/L) in water samples collected from well PB-711 (fig. 12). Among other sources, cadmium is present in wastes from electroplating and other chemical processes, and zinc is used in galvanizing and coating of iron and steel surfaces to prevent corrosion. Well PB-711 has black iron casing with a metal screen, which might account for the high cadmium and zinc concentrations detected at this well. Lead concentrations exceeded the PMCL (15 µg/L) in water samples collected from wells PB-875, PB-928, PB-1522, PB-1524, and PB-1653, with the maximum lead concentration (39 µg/L) occurring at well PB-928 (fig. 13). At wells PB-875, PB-1522, PB-1524, and PB-1653, the highest concentrations of lead occurred in March 1994, whereas at well PB-928 the highest lead concentration occurred in August 1994. The highest cadmium and zinc concentrations detected at well PB-711 also occurred in March 1994, while all concentrations of zinc from well PB-711 exceeded the SMCL (fig. 12). Lead entering the aquatic environment can be derived from urban runoff, precipitation, lead dust fallout, erosion, and leakance of soil and industrial waste (U.S. Environmental Protection Agency, 1977, p. 82).

Trace metal concentrations did not exceed the PMCL's or SMCL's in any water samples collected from the surface-water sites (table 9). Strontium exhibited the greatest range in concentration (130-700 µg/L), but there is no drinking-water standard for this constituent. Chromium, copper, and zinc had the next highest concentrations, but all were well below the PMCL's or SMCL's (table 9).

Nitrogen and Phosphorus Species

Nitrogen and phosphorus are needed for the growth and maintenance of all organisms, especially plant growth. Water bodies that receive increased concentrations of nitrogen and phosphorus tend to have dense plant growth or algal blooms and usually become eutrophic (Hem, 1985, p. 128). Elevated concentrations of nitrogen and phosphorus can be attributed to municipal wastewater, industrial wastewater, or agricultural runoff. Nitrogen occurs in natural waters in the form of organic nitrogen, ammonia, nitrite, and nitrate.

Table 8. Summary of trace metals exceeding the drinking-water standards in some ground-water samples at selected wells

[Concentrations shown in micrograms per liter. FDEP standard represents the Florida Department of Environmental Protection (1993b) drinking-water regulations standard. <, less than the value]

Constituent	Number of samples	FDEP standard	Percent of samples exceeding standard	Wells exceeding standard
Cadmium	40	5	<3	PB-711
Lead	40	15	<13	PB-875, PB-928, PB-1522, PB-1524, PB-1653
Zinc	40	5,000	10	PB-711

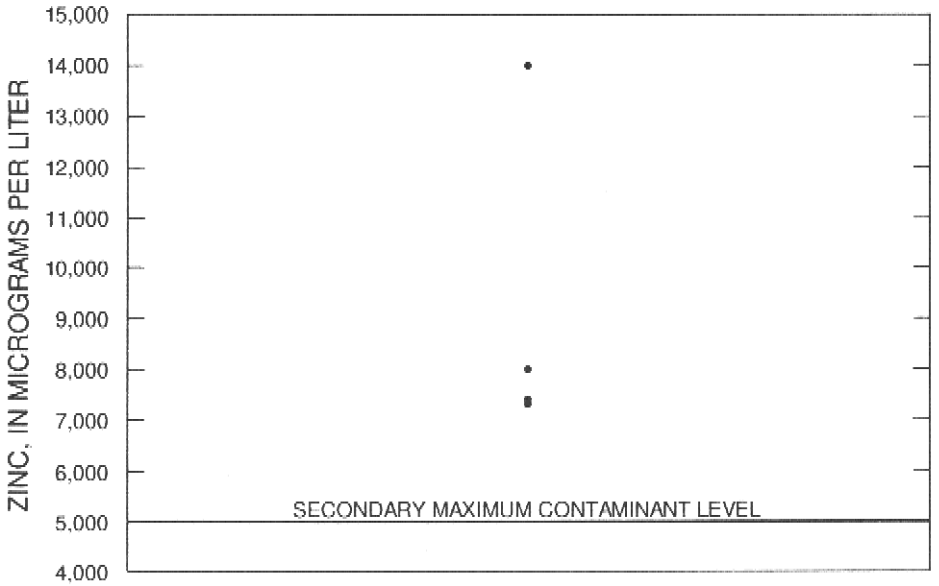
Table 9. Water-quality analysis of trace metals in the South Indian River Water Control District, 1989-94

[Concentrations shown in micrograms per liter, except where indicated; FDEP standard represents the Florida Department of Environmental Protection (1993b) drinking-water regulations standard. NS, no standard exists for particular constituent; <, less than the value; --, no data]

Constituent	FDEP standard	Type of maximum contaminant level	Ground-water samples					Surface-water samples				
			Number of samples	Maximum	Mean	Median	Minimum	Number of samples	Maximum	Mean	Median	Minimum
Arsenic (As)	50	PMCL[1]	40	4	0.8	0.5	<1.0	35	4	0.68	0.5	<1.0
Beryllium (Be)	4	PMCL[1]	40	1	.5	.5	<1.0	35	2	.61	.5	<1.0
Cadmium (Cd)	5	PMCL[1]	40	12	1.0	.5	<1.0	35	<1.0	--	--	<1.0
Chromium (Cr)	100	PMCL[1]	40	7	2.8	2.5	<5.0	35	7	3.2	2.5	<5.0
Copper (Cu)	1,000	SMCL[2]	40	57	9.5	3	<1.0	35	6	1.9	2	<1.0
Lead (Pb)	15	PMCL[1]	40	39	7.0	3	<1.0	35	3.0	1.17	1	<1.0
Mercury (Hg)	2	PMCL[1]	40	1.1	.16	.05	<.1	35	.6	.13	.05	<1.0
Nickel (Ni)	100	PMCL[1]	40	11	1.9	2	<1.0	35	2.0	.74	.5	<1.0
Selenium (Se)	50	PMCL[1]	40	<1.0	--	<1.0	<1.0	35	<1.0	--	<1.0	<1.0
Silver (Ag)	100	SMCL[2]	40	3	.6	.5	<1.0	35	1	.51	.5	<1.0
Strontium (Sr)	NS	None	338	2,000	682	530	250	193	700	424	430	130
Zinc (Zn)	5,000	SMCL[2]	40	14,000	958	20	<4.0	35	60	10.7	5	<4.0

[1]Primary maximum contaminant level (PMCL): The maximum permissible level of a contaminant in water, which has a direct relation to human health.

[2]Secondary maximum contaminant level (SMCL): Contaminants that affect the esthetic quality of drinking water. At high concentrations or values, health implications as well as esthetic degradation can also exist.



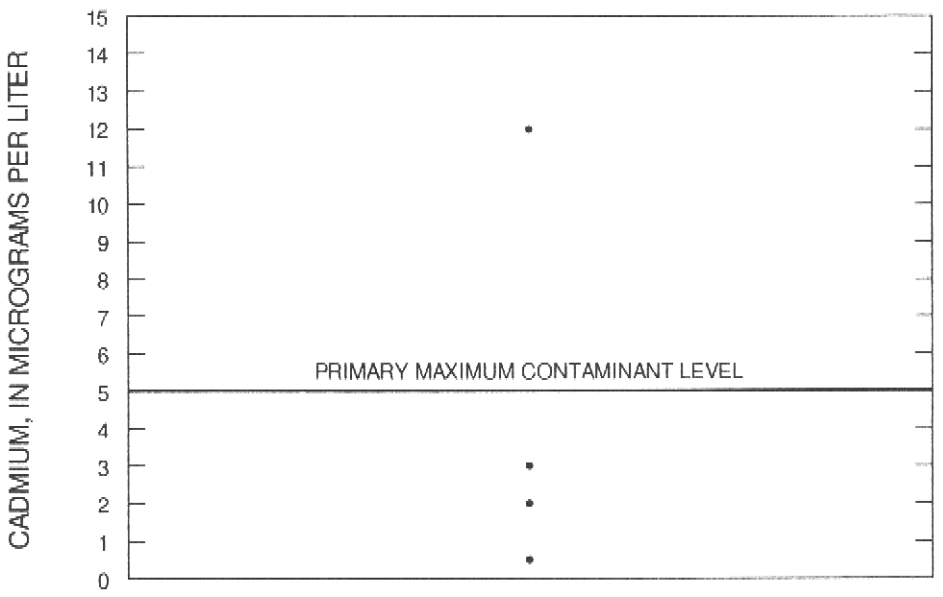


Figure 12. Cadmium and zinc concentrations at well PB-711, 1993-94.

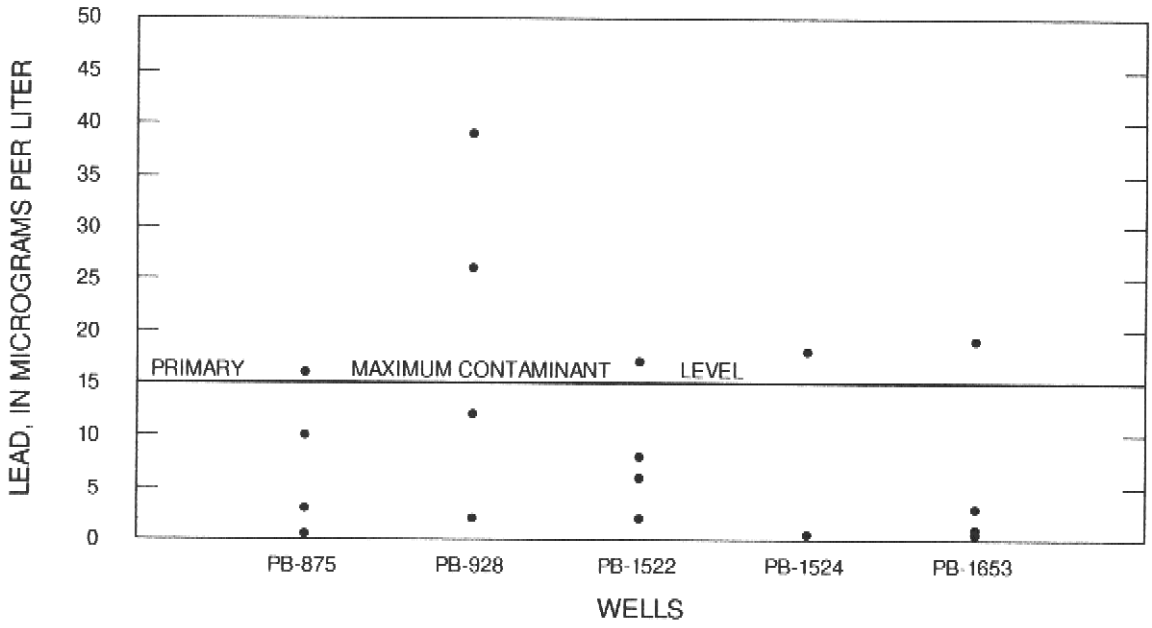


Figure 13. Lead concentrations at selected wells in the South Indian River Water Control District, 1993-94.

Ammonia is converted to nitrite and nitrate under aerobic conditions, which normally occur in surface water. High concentrations of ammonia generally are indicative of contamination from urban or agricultural sources. Total nitrite plus nitrate concentrations tend to be lower for ground water than for surface water due to anaerobic conditions existing in ground water; these conditions inhibit oxidation of ammonia to nitrite and nitrate. Cyanide is a toxic form of nitrogen that is a by-product of manufacturing processes. Organic carbon can be contributed to a water body through plant and animal waste. Total organic carbon is a measure of the dissolved and suspended organic carbon in a water sample.

Initial sampling for nitrogen and phosphorus species began in 1989 on a monthly basis at eight surface-water sites, periodically from 1991 to 1994 at four sites, and annually in 1993 at one site (app. II). Additionally, sampling was done on a periodic basis at 11 ground-water wells in 1993 and semiannually in 1994 (app. I). Total cyanide was determined at all ground-water wells and at selected surface-water sites, periodically in 1993 and semiannually in 1994 (app. I and II).

Nitrogen and phosphorus species concentrations did not exceed the PMCL's in any water samples (table 10). Median concentrations of total organic nitrogen and total nitrite plus nitrate nitrogen were higher in surface water than in ground water. The reverse was true for total ammonia nitrogen, total ammonia plus organic nitrogen, total organic carbon, and total phosphorus where median concentrations were higher in ground water than in surface water. The median concentration of total nitrite nitrogen (0.005 mg/L) was the same in both ground water and surface water. Many outliers (greater than the 99th percentile) were detected in surface-water samples (fig. 14). Total cyanide concentrations did not equal nor exceed the PMCL (0.2 mg/L) in any ground-water or surface-water samples. The highest total cyanide concentration (0.07 mg/L) was detected at site SW-1.

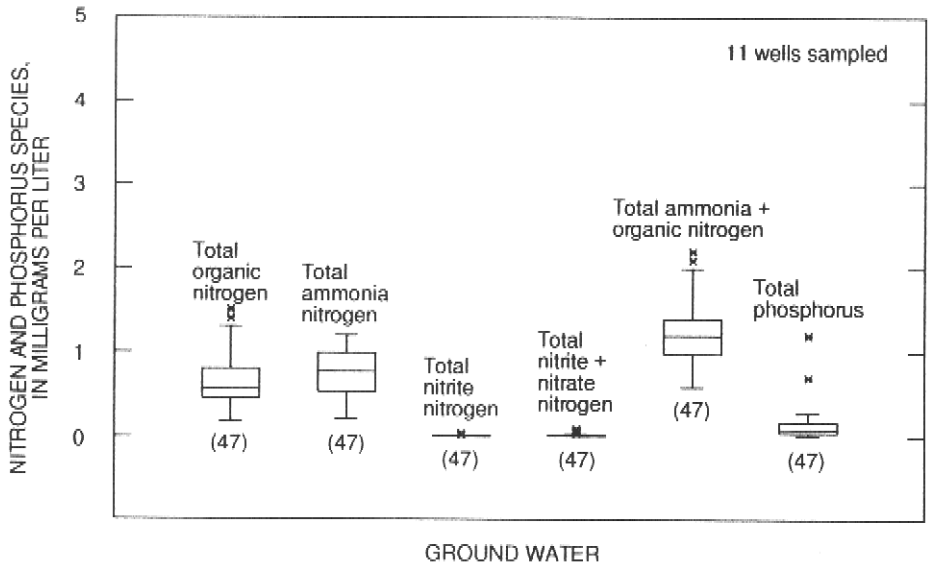
Results of the study indicate that in ground-water samples most of the nitrogen exists as total organic nitrogen and total ammonia nitrogen; whereas in surface-water samples, most of the nitrogen exists as total organic nitrogen. Box plots showing the distribution of concentrations of nitrogen and phosphorus species in ground water and surface water at the South Indian River Water Control District are depicted in figure 14.

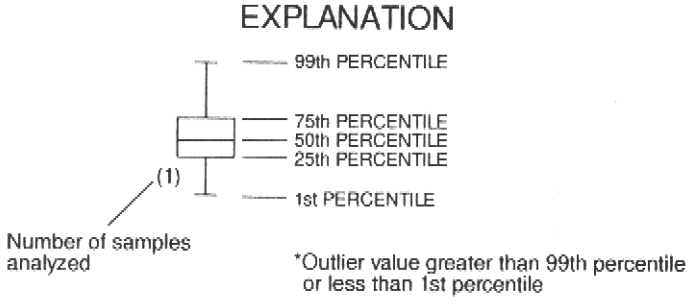
Table 10. Water-quality analysis of nitrogen and phosphorus species in the South Indian River Water Control District, 1989-94

[Concentrations shown in milligrams per liter, except where indicated; FDEP standard represents the Florida Department of Environmental Protection (1993b) drink-ing-water regulations standard. NS, no standard exists for particular constituent; <, less than the value; --, no data]

Constituent	FDEP standard	Type of maximum contaminant level	Ground-water samples					Surface-water samples				
			Number of samples	Maximum	Mean	Median	Minimum	Number of samples	Maximum	Mean	Median	Minimum
Total organic nitrogen	NS	None	47	9.4	0.85	0.56	0.18	188	4.6	0.86	0.78	0.36
Total ammonia nitrogen	NS	None	47	.91	.56	.6	.16	188	.42	.05	.03	<.01
Total nitrite nitrogen	1	PMCL[1]	47	.04	.008	.005	<.01	189	.03	.007	.005	<.01
Total nitrite plus nitrate nitrogen	10	PMCL[1]	47	.09	.022	.01	<.02	189	3.0	.08	.04	<.02
Total ammonia plus organic nitrogen	NS	None	47	10	1.43	1.2	.59	188	4.8	.91	.83	.40
Total organic carbon	NS	None	21	18	12	12	4.9	15	15	11	10	8.3
Total phosphorus	NS	None	47	1.2	.15	.09	<.02	189	.51	.04	.03	<.02
Total cyanide	0.2	PMCL[1]	40	<.02	--	<.02	<.02	35	.07	.01	.01	<.02

[1]Primary maximum contaminant level (PMCL): The maximum permissible level of a contaminant in water, which has a direct relation to human health.





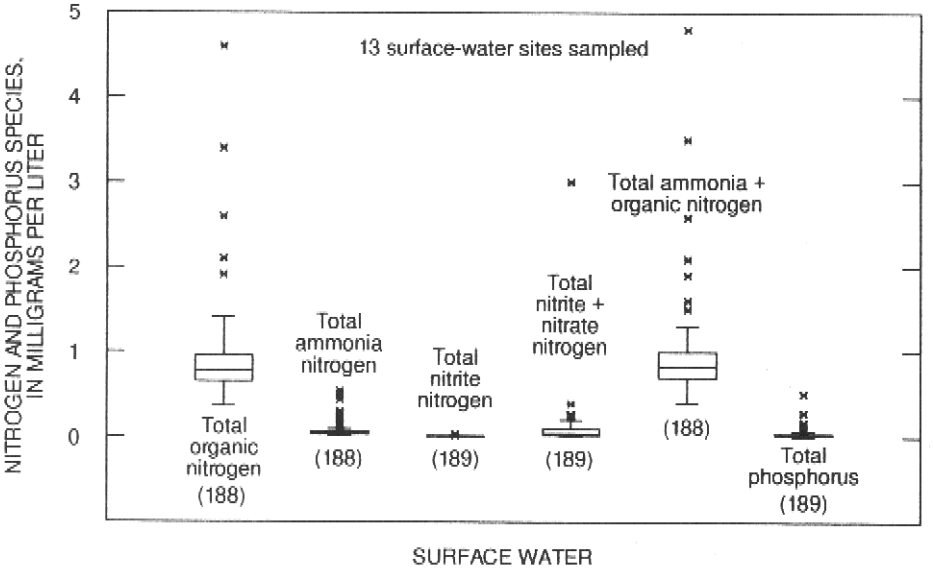


Figure 14. Distribution of concentrations of nitrogen and phosphorus species in ground water and surface water at selected sites in the South Indian River Water Control District.

Table 11. Synthetic organic compounds for which primary maximum contaminant levels exist and the laboratory analytical detection limits

[Compounds were analyzed using laboratory standard solutions of known chemical composition. Concentrations shown in micrograms per liter. Type of compound: 1, acid-extractable compounds; 2, base/neutral-extractable compounds; 3, pesticides; 4, volatile organic compounds. FDEP standard, Florida Department of Environmental Protection (1993) drinking water regulations standard; NPDES, National Pollutant Discharge Elimination System; <, less than the value]

Compound name	Type of compound	Number of samples	Detection limit	Maximum contaminant level[1]	NPDES pollutant
Benzene	4	12	<0.2	1	Yes
Benzo(a)pyrene	2	13	<10.0	0.2	Yes
Carbon tetrachloride	4	12	<.2	3	Yes
Chlordane	3	12	<.1	2	Yes
Dibromochloromethane	4	12	<.1	0.2	No
Dichlorobromomethane	4	12	<.2	5	No
1,2-Dichloroethane	4	12	<.2	3	Yes
1,1-Dichloroethylene	4	12	<.2	7	Yes
cis-1,2-Dichloroethylene	4	12	<.2	70	No
1,2-Dichloropropane	4	12	<.2	5	Yes
Endrin	3	12	<.06	2	Yes
Ethylbenzene	4	12	<.2	700	No
Heptachlor	3	12	<.03	0.4	Yes
Heptachlor epoxide	3	12	<.8	0.2	Yes
Hexachlorobenzene	2	13	<5.0	1	Yes
Hexachlorocyclopentadiene	2	13	<5.0	50	Yes
Lindane	3	12	<.03	0.2	No
Pentachlorophenol	1	13	<30.0	1	Yes
Styrene	3	12	<.2	100	Yes
Tetrachloroethylene	4	12	<.2	3	Yes
Toluene	4	12	<.2	1,000	Yes
Toxaphene	3	12	<2.0	3	Yes
1,2,4-Trichlorobenzene	2	13	<.5	70	Yes
1,1,1-Trichloroethane	4	12	<.2	200	Yes
1,1,2-Trichloroethane	4	12	<.2	5	Yes
Trichloroethylene	4	12	<.2	3	Yes
Vinyl chloride	4	12	<.2	1	Yes
Xylene	3	12	<.2	10,000	Yes

[1]Primary maximum contaminant level (PMCL): The maximum permissible level of a contaminant in water, which has a direct relation to human health.

Synthetic Organic Compounds

Generally, all natural water contains organic material due to the relation between water in the hydrologic cycle and living matter (Hem, 1985, p. 151). Organic material can be contributed to a water body by natural processes, human and animal waste disposal and urban and agricultural runoff, or in the form of synthetic organic compounds as a result of industrial processes. From July 1989 to August 1994, sampling of various synthetic organic compounds was conducted at several sites in the South Indian River Water Control District.

Beginning in July 1989, water samples were collected from selected ground-water wells and surface-water sites for GC/FID scan analysis. This analysis is a screening technique used for the detection of synthetic organic compounds in water and provides semiquantitative data without identification of specific compounds. Further sampling for many specific organic compounds at selected surface-water sites was added in 1992, including 113 compounds listed by the U.S. Environmental Protection Agency as part of the NPDES protocol. Beginning in August 1992, one surface-water site (SW-20) was sampled for NPDES pollutants on a storm-driven basis (app. II). Additionally, one other surface-water site (SW-22) was sampled in 1993, and two more surface-water sites (SW-1 and SW-10) were sampled in 1994 (app. II). Beginning in October 1993, water samples were collected from three surface-water sites for GC/FID scan analysis.

The synthetic organic compounds that were sampled include acid-extractable compounds, base/neutral-extractable compounds, pesticides, and volatile organic compounds. Table 11 lists the compounds for which PMCL's exist and the laboratory analytical detection limits. NPDES pollutants were not detected, and concentrations of compounds (for which PMCL's exist) did not equal nor exceed the PMCL's at any sites during the monitoring program. However, the PMCL's for heptachloride epoxide, pentachlorophenol, hexachlorobenzene, and benzo(a)pyrene were below the laboratory minimum detection limit. Therefore, concentrations could still exceed the PMCL's, even though the compounds were not detected. Total phenols, which are aromatic synthetic organic compounds, were sampled at all ground-water wells and selected surface-water sites beginning in 1993 (app. II), but none were detected.

Results of the GC/FID analysis indicate that some water samples at sites in the South Indian River Water Control District contained trace concentrations of organic compounds. However, water samples at several sites exhibited concentrations greater than 50 µg/L, the threshold above which individual compounds should be determined (Khanh Doan, U.S. Geological Survey Quality Service Unit, Ocala, Fla., oral commun., 1994). The sites for which concentrations of compounds were at or above 50 µg/L are presented in table 12.

Table 12. Quantitative summary of synthetic organic compounds exceeding the threshold (50 micrograms per liter) above which individual compounds should be determined

[Concentration range shown in micrograms per liter]

Sampling date	Concentration range	Wells or sites exceeding the 50 microgram per liter threshold
September 1989	100-200	PB-880, PB-928, PB-1552, PB-1652, SW-4, SW-6, SW-10
December 1989	50-60	PB-1524, PB-1652, SW-6
March 1990	10-300	PB-1522
February 1991	140-160	PB-1524

SUMMARY AND CONCLUSIONS

The South Indian River Water Control District is located in northern Palm Beach County in an area where no public-water supplies exist, and thus many residents must rely on private wells for domestic water supplies and septic tanks for waste disposal. The availability of a potable water supply for the area has become an increasing concern to water-management officials and others. The U.S. Geological Survey, in cooperation with the South Indian River Water Control District, began an extensive ground-water and surface-water quality study in July 1989 to define the baseline water quality within the District and to develop a data base for future water-resource planning and management. The sampling program included 11 ground-water wells and 14 surface-water sites located within the District study area. Water samples were collected on a periodic basis from 1989 to 1994 for determination of major inorganic constituents and physical characteristics, trace metals, nitrogen and phosphorus species, and synthetic organic compounds.

The predominant water type within the South Indian River Water Control District is calcium bicarbonate, which is due to the dissolution of limestone from the surficial aquifer system (the major source of freshwater supply for Palm Beach County). However, mixed-cation and mixed-anion type waters also exist in varying amounts as well as sodium bicarbonate type water. Highly mineralized sodium chloride type water exists in shallow and deep zones of the surficial aquifer system in western areas of the District, causing the water to be unsuitable as a potable supply.

Concentrations or values of sodium, chloride, dissolved solids, and color exceeded the State drinking-water standards in some ground-water and surface-water samples. Sodium and chloride concentrations exceeded the standards (160 and 250 mg/L, respectively) in ground water at only two wells; dissolved-solids concentrations exceeded the standard (500 mg/L) at five ground-water wells and one surface-water site; and color values exceeded the standard (15 Pt-Co units) at all 11 ground-water wells and all 14 surface-water sites. The highest dissolved-solids concentration (1,780 mg/L) was detected in one ground-water sample (well PB-1552), indicating a high degree of mineralization. The highest dissolved-solids concentration (520 mg/L) detected at one surface-water site (SW-1) exceeded the State standard, but amounted to less than 1 percent of all samples collected at the 13 sites. Elevated color values detected in ground water at all of the wells were probably the result of organic material deposited in the surficial aquifer system.

Cadmium, lead, and zinc were the only trace metals that exceeded State drinking-water standards in the ground-water samples. Cadmium and zinc concentrations exceeded the standards (5 and 5,000 µg/L, respectively) in ground water at only one well (PB-711). Lead concentrations exceeded the standard (15 µg/L) in ground water at five wells. Trace metal concentrations did not exceed State drinking-water standards in any surface-water samples.

Determinations were made of selected nitrogen and phosphorus species for this study. However, no concentrations exceeded the State drinking-water standards in any ground-water or surface-water samples.

The synthetic organic compounds that were determined included acid-extractable compounds, base/neutral-extractable compounds, pesticides, and volatile organic compounds. No concentrations of compounds which are part of the NPDES protocol or for which PMCL's exist were equaled or exceeded during the storm-driven monitoring of four surface-water sites. Some compounds were detected during GC/FID analysis in concentrations greater than 50 µg/L. Water samples collected from six wells and three surface-water sites in the study area had concentrations of organic compounds at or above 50 µg/L.

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APPENDIX I

Dates of Sampling for Water-Quality Constituents at Selected Ground-Water Wells

Appendix I. Dates of sampling for water-quality constituents at selected ground-water wells

[Gas chromatograph/flame ionization detection reconnaissance sampling was conducted at all wells, but on a periodic basis]

Well number	Dates of sampling for major inorganic constituents	Dates of sampling for nitrogen and phosphorus species	Dates of sampling for cyanide	Dates of sampling for trace metals	Dates of sampling for chemical oxygen demand	Dates of sampling for total organic carbon	Dates of sampling for phenols
PB-711	07-19-89 to 08-11-94	02-11-93 to 08-11-94	07-19-93 to 08-11-94	07-19-93 to 08-11-94	07-19-93 & 10-06-93	07-19-93 & 10-06-93	07-19-93 & 10-06-93
PB-875	07-18-89 to 08-10-94	03-18-93 to 08-10-94	07-15-93 to 08-10-94	07-15-93 to 08-10-94	07-15-93 & 10-04-93	07-15-93 & 10-04-93	07-15-93 & 10-04-93
PB-880	07-19-89 to 08-10-94	07-15-93 to 08-10-94	07-15-93 to 08-10-94	07-15-93 to 08-10-94	07-15-93 & 10-04-93	07-15-93 & 10-04-93	07-15-93 & 10-04-93
PB-928	07-19-89 to 08-11-94	07-14-93 to 08-11-94	07-14-93 to 08-11-94	07-14-93 to 08-11-94	07-14-93 & 10-06-93	07-14-93 & 10-06-93	07-14-93 & 10-06-93
PB-1520	07-18-89 to 08-11-94	03-18-93 to 08-11-94	07-20-93 to 10-06-93	07-20-93 to 10-06-93	07-20-93 & 10-06-93	07-20-93 & 10-06-93	07-20-93 & 10-06-93
PB-1522	07-18-89 to 08-09-94	03-17-93 to 08-09-94	07-19-93 to 08-09-94	07-19-93 to 08-09-94	07-19-93 & 10-06-93	07-19-93 & 10-06-93	07-19-93 & 10-06-93
PB-1524	07-18-89 to 08-09-94	03-17-93 to 08-09-94	07-19-93 to 08-09-94	07-19-93 to 08-09-94	07-19-93 & 10-06-93	07-19-93 & 10-06-93	07-19-93 & 10-06-93
PB-1552	07-19-89 to 08-09-94	10-06-93 to 08-09-94	10-06-93 to 08-09-94	10-06-93 to 08-09-94	10-06-93	10-06-93	10-06-93
PB-1651	07-18-89 to 08-10-94	07-20-93 to 08-10-94	07-20-93 to 08-10-94	07-20-93 to 08-10-94	07-20-93 & 10-06-93	07-20-93 & 10-06-93	07-20-93 & 10-06-93
PB-1652	07-19-89 to 08-10-94	07-20-93 to 08-10-94	07-20-93 to 08-10-94	07-20-93 to 08-10-94	07-20-93 & 10-06-93	07-20-93 & 10-06-93	07-20-93 & 10-06-93
PB-1653	08-23-89 to 08-08-94	07-19-93 to 08-08-94	07-19-93 to 08-08-94	07-19-93 to 08-08-94	07-19-93 & 10-04-93	07-19-93 & 10-04-93	07-19-93 & 10-04-93

APPENDIX II

Dates of Sampling for Water-Quality Constituents at Selected Surface-Water Sites

Appendix II. Dates of sampling for water-quality constituents at selected surface-water sites

[Gas chromatograph/flame ionization detection reconnaissance sampling was conducted at all sites, but on a periodic basis; NPDES, National Pollutant Discharge Elimination System]

Site number	Dates of sampling for major inorganic constituents	Dates of sampling for nitrogen and phosphorus species	Dates of sampling for cyanide	Dates of sampling for trace metals	Dates of sampling for chemical oxygen demand	Dates of sampling for total organic carbon	Dates of sampling for phenols	Dates of sampling for NPDES pollutants
SW-1	07-17-89 to 09-13-94	07-17-89 to 09-13-94	07-14-93 to 09-13-94	07-14-93 to 09-13-94	07-14-93 & 09-29-93	07-14-93 & 09-29-93	07-14-93 to 09-13-94	06-14-94 & 09-13-94
SW-2	07-17-89 to 08-09-94	07-17-89 to 08-09-94	03-08-94 to 08-09-94	03-08-94 to 08-09-94	--	--	--	--
SW-3	07-17-89 to 08-22-89	07-17-89 to 11-04-91	--	--	--	--	--	--
SW-4	07-17-89 to 08-10-94	07-17-89 to 08-10-94	07-14-93 to 08-10-94	07-14-93 to 08-10-94	07-14-93 & 09-29-93	07-14-93 & 09-29-93	07-14-93 & 09-29-93	--
SW-5	07-17-89 to 05-28-92	07-17-89 to 05-28-92	--	--	--	--	--	--
SW-6	07-17-89 to 08-10-94	07-17-89 to 08-10-94	07-15-93 to 08-10-94	07-15-93 to 08-10-94	07-15-93 & 10-04-93	07-15-93 & 10-04-93	07-15-93 & 10-04-93	--
SW-7	08-22-89 to 11-04-91	08-22-89 to 11-04-91	--	--	--	--	--	--
SW-8	03-12-91 to 10-06-93	03-12-91 to 07-02-92	07-15-93 to 10-06-93	07-15-93 to 10-06-93	07-15-93 & 10-06-93	07-15-93 & 10-06-93	07-15-93 & 10-06-93	--
SW-9	07-31-90 to 05-21-92	--	--	--	--	--	--	--
SW-10	09-18-89 to 09-13-94	09-18-89 to 09-13-94	07-14-93 to 09-13-94	07-14-93 to 09-13-94	07-14-93 & 09-30-93	07-14-93 & 09-30-93	07-14-93 to 09-13-94	06-14-94 & 09-13-94
SW-20	07-02-92 to 09-29-93	07-02-92 to 09-29-93	07-02-92 to 09-29-93	07-02-92 to 09-29-93	07-15-93 & 09-29-93	07-15-93 & 09-29-93	--	08-05-92 to 09-29-93
SW-21	09-22-92 to 09-30-93	09-22-92 to 09-30-93	07-14-93 to 09-30-93	07-14-93 to 09-30-93	07-14-93 & 09-30-93	07-14-93 & 09-30-93	07-14-93 & 09-30-93	--
SW-22	09-29-93	09-29-93	09-29-93	09-29-93	09-29-93	09-29-93	09-29-93	09-29-93
SW-23	03-08-94 to 08-08-94	03-08-94 to 08-08-94	03-08-94 to 08-08-94	03-08-94 to 08-08-94	--	--	--	--

APPENDIX III

Statistical Summary of Selected Ground-Water Quality Data, 1989-94

If the number of observations is greater than 1 or less than 5 for ***uncensored*** *data, only the maximum, minimum, and mean are reported.*

If the number of observations is equal to 1 for ***censored*** *and* ***uncensored*** *data, only the maximum is reported.*

If the total number of observations above the detection limit is less than 5 for ***censored*** *data, the estimated values are not reported. If the total number of observations above and below the detection limit is greater than 1 and less than or equal to 5 for* ***censored*** *data, only the maximum and minimum are reported.*

Well PB-711

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	29	120	36	50	90	54.5	46	41	37
Magnesium (mg/L as Mg)	29	4	0.6	1.171	3	1.25	1	0.9	0.65
Sodium (mg/L as Na)	29	22	7.8	10.783	20	11	10	9	7.90
Potassium (mg/L as K)	29	1	0.2	0.431	0.91	0.58	0.3	0.29	0.22
Chloride (mg/L as Cl)	29	32	13	19.724	30	22.5	19	16	13
Sulfate (mg/L as SO_4)	29	72	0.2	22.821	67	26	18	12	2.05
Fluoride (mg/L as F)	29	0.2	--	*0.07	*0.2	*0.089	*0.054	*0.035	*0.01
Dissolved solids (mg/L)	29	381	164	235	344.5	272	216	202.5	174
Hardness (mg/L as $CaCO_3$)	29	320	95	129.138	235	140	120	110	97.5
Silica (mg/L as SiO_2)	29	17	6.2	10.01	14.5	12	10	8.8	6.2
Color (Pt-Co units)	29	1,400	25	402.931	1,100	530	320	210	42.5
Organic nitrogen (mg/L as N)	5	0.75	0.49	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	5	0.46	0.35	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	5	1.2	0.94	--	--	--	--	--	--
Total phosphorus (mg/L as P)	5	0.25	0.09	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	4	15	1	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	29	860	250	326.207	620	340	310	275	255
Zinc (µg/L as Zn)	4	14,000	7,300	--	--	--	--	--	--

Well PB-875

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit; mg/L, milligrams per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maxi-mum	Mini-mum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	33	95	60	78.485	92.9	82.5	80	75.5	61.4
Magnesium (mg/L as Mg)	33	9.1	2.4	3.258	5.39	3.3	3.2	2.85	2.4
Sodium (mg/L as Na)	33	32	20	26.242	32	28	26	25	21.4
Potassium (mg/L as K)	33	1.2	0.3	0.688	1.06	0.84	0.72	0.5	0.37
Chloride (mg/L as Cl)	33	66	24	42.6	64.4	50	41	36	24.8
Sulfate (mg/L as SO_4)	33	10	--	*1.367	*6.43	*1.45	*0.6	*0.3	*0.09
Fluoride (mg/L as F)	33	0.2	--	*0.077	*0.2	*0.1	*0.062	*0.04	*0.02

Well PB-880

[milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	30	130	100	118	124.5	120	120	120	105.5
Magnesium (mg/L as Mg)	30	23	17	19.167	21.9	19.25	19	19	17.55
Sodium (mg/L as Na)	30	130	32	74.9	124.5	98	67.5	54.5	36.4
Potassium (mg/L as K)	30	3.8	1.9	2.997	3.69	3.3	3	2.775	2.1
Chloride (mg/L as Cl)	33	130	38	64.303	116	84	52	46	39.4
Sulfate (mg/L as SO_4)	30	44	15	27.267	39.05	31	26	24	17.75
Fluoride (mg/L as F)	30	0.4	0.19	0.233	0.4	0.2	0.2	0.2	0.19
Dissolved solids (mg/L)	30	774	536	616.4	747.6	669	586.5	571.75	548.65
Hardness (mg/L as $CaCO_3$)	30	410	320	375.333	399	380	380	380	336.5
Silica (mg/L as SiO_2)	30	32	27	28.833	31.45	29	29	28	27
Color (Pt-Co units)	30	70	30	54	64.5	60	50	50	38.25
Organic nitrogen (mg/L as N)	3	0.8	0.64	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	3	0.65	0.4	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	3	1.3	1.2	--	--	--	--	--	--
Total phosphorus (mg/L as P)	3	0.08	0.05	--	--	--	--	--	--
Arsenic (µg/L as As)	3	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	3	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	3	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	3	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	3	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	3	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	3	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	3	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	3	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	30	1,300	1,100	1,196.677	1,300	1,200	1,200	1,200	1,100
Zinc (µg/L as Zn)	3								

Well PB-928

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	29	120	65	112.241	120	120	110	110	87.5
Magnesium (mg/L as Mg)	29	4	0.77	3.675	3.95	3.9	3.8	3.7	2.08
Sodium (mg/L as Na)	29	22	9.5	20.672	22	22	21	20.5	14.25
Potassium (mg/L as K)	29	1.2	0.56	0.795	1.1	0.925	0.72	0.695	0.57
Chloride (mg/L as Cl)	29	39	19	31.724	36.5	32	32	31	24.5
Sulfate (mg/L as SO_4)	29	11	--	*0.635	*6.6	*0.2	*0.084	*0.017	*0.0
Fluoride (mg/L as F)	29	0.2	--	*0.086	*0.2	*0.1	*0.069	*0.044	*0.02
Dissolved solids (mg/L)	29	416	223	385.034	412	398	392	382.5	285.5
Hardness (mg/L as $CaCO_3$)	29	320	170	297.241	320	320	290	290	230
Silica (mg/L as SiO_2)	29	19	7.7	17.369	19	18.5	18	17	10.85
Color (Pt-Co units)	29	320	20	96.379	320	100	70	40	22.5
Organic nitrogen (mg/L as N)	4	0.49	0.35	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	4	0.82	0.71	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	4	1.2	1.1	--	--	--	--	--	--
Total phosphorus (mg/L as P)	4	--	--	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	14	1	--	--	--	--	--	--
Lead (µg/L as Pb)	4	39	2	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	29	880	400	820.345	880	860	840	805	590
Zinc (µg/L as Zn)	4	180	60	--	--	--	--	--	--

Well PB-1520

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	33	140	85	105.394	133	120	100	97	85
Magnesium (mg/L as Mg)	33	7.8	1.9	2.982	4.93	3.2	2.7	2.55	2.11
Sodium (mg/L as Na)	33	22	14	16.485	21.3	17	16	15	14
Potassium (mg/L as K)	33	1.2	0.3	0.548	1.06	0.7	0.49	0.39	0.3
Chloride (mg/L as Cl)	33	57	16	31.455	54.9	40	26	22	16.7
Sulfate (mg/L as SO_4)	33	19	--	*1.478	*12.42	*0.4	*0.078	*0.012	*0.0
Fluoride (mg/L as F)	33	0.3	--	*0.112	*0.3	*0.1	*0.1	*0.057	*0.03
Dissolved solids (mg/L)	33	530	233	372.697	521.6	418.5	347	326	279.2
Hardness (mg/L as $CaCO_3$)	33	370	220	275.151	349	310	260	250	220
Silica (mg/L as SiO_2)	33	12	9.6	10.655	12	11	11	10	9.88
Color (Pt-Co units)	33	160	70	107.879	146	120	100	100	77
Organic nitrogen (mg/L as N)	5	1	0.47	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	5	0.87	0.6	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	5	1.6	1.1	--	--	--	--	--	--
Total phosphorus (mg/L as P)	5	0.14	0.03	--	--	--	--	--	--
Arsenic (µg/L as As)	2	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	2	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	2	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	2	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	2	9	7	--	--	--	--	--	--
Lead (µg/L as Pb)	2	2	1	--	--	--	--	--	--
Mercury (µg/L as Hg)	2	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	2	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	33	720	450	542.727	692	565	530	505	450
Zinc (µg/L as Zn)	2	40	20	--	--	--	--	--	--

Well PB-1522

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit.
Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	31	93	75	85.097	90	86	85	84	78
Magnesium (mg/L as Mg)	31	4.3	3.1	3.787	4.3	3.9	3.8	3.7	3.28
Sodium (mg/L as Na)	31	30	20	21.935	29.4	22	21	21	20.6
Potassium (mg/L as K)	31	1.9	0.54	0.787	1.36	0.89	0.8	0.6	0.57
Chloride (mg/L as Cl)	31	36	27	30.484	34.8	31	30	29	28.2
Sulfate (mg/L as SO_4)	31	3.9	--	*0.338	*2.88	*0.3	*0.08	*0.026	*0.0
Fluoride (mg/L as F)	31	0.4	0.28	0.306	0.4	0.3	0.3	0.3	0.29
Dissolved solids (mg/L)	31	343	291	311.323	334	318	311	303	293.4
Hardness (mg/L as $CaCO_3$)	31	250	200	229.355	244	230	230	230	206.0
Silica (mg/L as SiO_2)	31	20	16	18.065	19.4	19	18	18	16.6
Color (Pt-Co units)	31	50	10	24.194	44	30	20	20	10
Organic nitrogen (mg/L as N)	5	1.4	0.23	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	5	0.79	0.69	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	5	2.2	0.99	--	--	--	--	--	--
Total phosphorus (mg/L as P)	5	0.24	0.04	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	45	10	--	--	--	--	--	--
Lead (µg/L as Pb)	4	17	2	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	11	2	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	31	530	350	395.161	512	400	390	380	356
Zinc (µg/L as Zn)	4	110	6	--	--	--	--	--	--

Well PB-1524

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	33	170	120	142.121	170	160	140	130	120
Magnesium (mg/L as Mg)	33	31	20	25.273	30.3	28	26	22	20.7
Sodium (mg/L as Na)	33	410	200	284.849	396	350	260	230	200
Potassium (mg/L as K)	33	16	9.3	12.245	16	14	12	10.5	9.44
Chloride (mg/L as Cl)	33	590	260	412.424	569	505	390	325	274
Sulfate (mg/L as SO_4)	33	160	75	115.03	160	140	100	95	78.5
Fluoride (mg/L as F)	33	0.4	0.2	0.246	0.4	0.3	0.2	0.2	0.2
Dissolved solids (mg/L)	33	1,670	942	1,282.121	1,642	1,500	1,200	1,105	960.2
Hardness (mg/L as $CaCO_3$)	33	550	380	460.606	550	520	460	420	387
Silica (mg/L as SiO_2)	33	21	18	19.545	21	20	20	19	18
Color (Pt-Co units)	33	60	30	44.848	60	50	45	40	30
Organic nitrogen (mg/L as N)	5	1.1	0.45	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	5	0.91	0.77	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	5	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	5	2	1.3	--	--	--	--	--	--
Total phosphorus (mg/L as P)	5	0.28	0.15	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	57	1	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	33	2,000	880	1,077.576	1,510	1,200	1,000	960	894
Zinc (µg/L as Zn)	4	270	5	--	--	--	--	--	--

Well PB-1552

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maxi-mum	Mini-mum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	25	170	110	152.8	167	160	160	150	113
Magnesium (mg/L as Mg)	25	37	21	33.24	36.7	36	35	33	21.3
Sodium (mg/L as Na)	25	440	230	397.6	440	430	420	400	236
Potassium (mg/L as K)	25	21	11	18.04	21	20	19	17	11.3
Chloride (mg/L as Cl)	25	650	340	579.6	647	620	610	580	352
Sulfate (mg/L as SO_4)	25	190	90	169.6	190	180	180	170	99
Fluoride (mg/L as F)	25	0.5	0.2	0.303	0.47	0.3	0.3	0.3	0.2
Dissolved solids (mg/L)	25	1,780	1,090	1,651.2	1,777	1,760	1,740	1,640	1,093
Hardness (mg/L as $CaCO_3$)	25	570	360	520.8	564	550	540	515	378
Silica (mg/L as SiO_2)	25	22	10	20.36	22	22	21	20	11.5
Color (Pt-Co units)	25	60	30	39	60	40	40	30	30
Organic nitrogen (mg/L as N)	3	1.4	0.56	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	3	0.84	0.69	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	3	2.1	1.4	--	--	--	--	--	--
Total phosphorus (mg/L as P)	3	0.29	0.05	--	--	--	--	--	--
Arsenic (µg/L as As)	3	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	3	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	3	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	3	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	3	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	3	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	3	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	3	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	3	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	25	1,500	960	1,373.2	1,500	1,500	1,400	1,350	963
Zinc (µg/L as Zn)	3	90	5,000	--	--	--	--	--	--

Well PB-1651

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	32	95	53	74.094	93.05	84	76	67.25	53
Magnesium (mg/L as Mg)	32	9.6	2.2	3.613	6.22	3.975	3.55	2.9	2.39
Sodium (mg/L as Na)	31	30	15	23.129	30	26	23	20	16.2
Potassium (mg/L as K)	32	1.7	0.7	1.142	1.57.	1.375	1.2	0.885	0.76
Chloride (mg/L as Cl)	32	57	26	40.969	56.35	49	40	34.25	26.65
Sulfate (mg/L as SO_4)	32	120	4.3	38.634	113.5	43.5	33.5	27	8
Fluoride (mg/L as F)	32	0.4	--	*0.136	*0.4	*0.2	*0.1	*0.056	*0.02
Dissolved solids (mg/L)	32	388	241	326.219	386.7	366.5	329.5	286.5	243.6
Hardness (mg/L as $CaCO_3$)	32	260	140	203.438	253.5	230	205	180	140
Silica (mg/L as SiO_2)	32	16	3.9	5.603	11.32	5.6	5.15	4.45	4.03
Color (Pt-Co units)	32	140	20	71.406	127	87.5	70	50	33
Organic nitrogen (mg/L as N)	4	9.4	0.74	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	4	0.62	0.25	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	4	10	1	--	--	--	--	--	--
Total phosphorus (mg/L as P)	4	1.2	0.06	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	10	1	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	32	590	360	482.813	583.5	547.5	480	425	366.5
Zinc (µg/L as Zn)	4	60	9	--	--	--	--	--	--

Well PB-1652

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit.
Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	31	110	56	84.452	104	94	87	76	57.8
Magnesium (mg/L as Mg)	31	4	2.8	3.332	3.94	3.6	3.3	3	2.86
Sodium (mg/L as Na)	31	29	18	24.903	29	26	25	24	19.8
Potassium (mg/L as K)	31	1.3	0.34	0.833	1.24	1	0.84	0.6	0.42
Chloride (mg/L as Cl)	31	52	26	41.516	52	44	41	39	27.2
Sulfate (mg/L as SO_4)	31	76	0.4	19.665	60.4	29	19	8.6	0.46
Fluoride (mg/L as F)	31	0.4	--	*0.184	*0.4	*0.2	*0.2	*0.1	*0.06
Dissolved solids (mg/L)	31	390	242	340.903	382.2	360	354	322	252.2
Hardness (mg/L as $CaCO_3$)	31	290	150	225.806	278	250	230	210	156
Silica (mg/L as SiO_2)	31	13	4.5	9.332	13	12	10	6.1	4.56
Color (Pt-Co units)	31	140	40	85.161	116	100	90	70	46
Organic nitrogen (mg/L as N)	4	1.5	0.41	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	4	0.52	0.16	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	4	2	0.9	--	--	--	--	--	--
Total phosphorus (mg/L as P)	4	0.7	0.12	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	8	2	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	3	1	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	31	680	380	554.839	680	620	560	510	392
Zinc (µg/L as Zn)	4	30	10	--	--	--	--	--	--

Well PB-1653

[milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	32	100	81	91.969	98.7	95.75	92	88.25	84.25
Magnesium (mg/L as Mg)	32	5.1	3.2	3.916	4.645	4.1	3.95	3.7	3.26
Sodium (mg/L as Na)	32	130	85	106.688	123.5	110	110	98.5	86.3
Potassium (mg/L as K)	32	1.2	0.45	0.698	1.135	0.79	0.695	0.51	0.46
Chloride (mg/L as Cl)	32	150	100	120.938	143.5	137.5	120	110	100
Sulfate (mg/L as SO_4)	32	33	7.9	16.591	27.15	18.75	16	14	9.91
Fluoride (mg/L as F)	32	0.6	0.39	0.434	0.535	0.5	0.4	0.4	0.39
Dissolved solids (mg/L)	32	622	488	554.313	618.75	571.75	556	525.75	501
Hardness (mg/L as $CaCO_3$)	32	270	220	246.875	270	260	250	240	226.5
Silica (mg/L as SiO_2)	32	20	16	17.875	19.35	18	18	17	16
Color (Pt-Co units)	32	110	50	71.875	103.5	80	70	60	50
Organic nitrogen (mg/L as N)	4	1.5	0.18	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	4	0.41	0.34	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	4	1.8	0.59	--	--	--	--	--	--
Total phosphorus (mg/L as P)	4	0.27	0.03	--	--	--	--	--	--
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	32	560	430	504.375	560	530	515	467.5	430
Zinc (µg/L as Zn)	4	--	--	--	--	--	--	--	--

APPENDIX IV

Statistical Summary of Selected Surface-Water Quality Data, 1989-94

If the number of observations is greater than 1 or less than 5 for ***uncensored*** *data, only the maximum, minimum, and mean are reported.*

If the number of observations is equal to 1 for ***censored*** *and* ***uncensored*** *data, only the maximum is reported.*

If the total number of observations above the detection limit is less than 5 for ***censored*** *data, the estimated values are not reported. If the total number of observations above and below the detection limit is greater than 1 and less than or equal to 5 for* ***censored*** *data, only the maximum and minimum are reported.*

Site SW-1

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	33	97	29	64.182	94.9	79.5	62	50	36
Magnesium (mg/L as Mg)	33	7.8	2	4.724	7.66	6.45	4.4	3.2	2.28
Sodium (mg/L as Na)	33	63	12	32.576	58.8	46	27	21.5	14.1
Potassium (mg/L as K)	33	4.4	1	1.833	3.07	2.1	1.7	1.5	1
Chloride (mg/L as Cl)	33	92	19	51.636	90.6	72.5	49	31.5	23.2
Sulfate (mg/L as SO_4)	33	36	4.7	20.194	35.3	27	17	12.5	7.5
Fluoride (mg/L as F)	33	0.4	--	*0.157	*0.33	*0.2	*0.14	*0.1	*0.05
Dissolved solids (mg/L)	33	520	149	317.849	467.5	416	324	233.5	181.9
Hardness (mg/L as $CaCO_3$)	33	270	81	180.333	263	230	170	140	101.3
Silica (mg/L as SiO_2)	33	18	3.1	8.603	17.3	11	8.2	5.7	3.38
Color (Pt-Co units)	33	200	30	63.636	144	80	55	40	30
Organic nitrogen (mg/L as N)	33	1.2	0.36	0.787	1.2	0.88	0.76	0.64	0.47
Ammonia nitrogen (mg/L as N)	33	0.06	0.01	0.032	0.053	0.04	0.03	0.02	0.01
Nitrite nitrogen (mg/L as N)	33	0.01	--	*0.01	*0.01	*0.01	*0.01	*0.01	*0.01
Nitrite + nitrate nitrogen (mg/L as N)	33	0.27	0.02	0.084	0.214	0.12	0.07	0.04	0.02
Ammonia + organic nitrogen (mg/L as N)	33	1.2	0.4	0.814	1.2	0.915	0.79	0.68	0.52
Total phosphorus (mg/L as P)	33	0.08		*0.033	*0.08	*0.04	*0.03	*0.02	*0.01
Arsenic (µg/L as As)	6	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	6	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	6	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	6	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	6	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	6	2	1	1.5	2	2	1.5	1	1
Mercury (µg/L as Hg)	6	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	6	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	6	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	33	670	160	427.879	642	575	390	315	195
Zinc (µg/L as Zn)	6	--	--	--	--	--	--	--	--

Site SW-2

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maxi-mum	Mini-mum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	27	83	57	72.926	82.6	78	74	68	57.4
Magnesium (mg/L as Mg)	27	10	3.9	5.789	9.6	6	5.4	5	4.14
Sodium (mg/L as Na)	27	74	19	37.444	70.4	38	34	31	22.6
Potassium (mg/L as K)	27	2.2	1	1.459	2.08	1.6	1.4	1.2	1.04
Chloride (mg/L as Cl)	27	100	29	56.704	99.2	58	52	47	34.6
Sulfate (mg/L as SO_4)	27	46	18	28.148	44.4	32	27	23	18.4
Fluoride (mg/L as F)	27	0.4	0.1	0.23	0.4	0.2	0.2	0.2	0.14
Dissolved solids (mg/L)	27	454	261	346.778	453.6	356	337	321	278.2
Hardness (mg/L as $CaCO_3$)	27	240	160	206.667	236	220	210	190	164
Silica (mg/L as SiO_2)	27	16	4.9	10.719	15.6	12	10	9.4	5.74
Color (Pt-Co units)	27	100	30	47.778	92	55	40	40	30
Organic nitrogen (mg/L as N)	27	1.3	0.44	0.673	1.156	0.71	0.67	0.55	0.47
Ammonia nitrogen (mg/L as N)	27	0.23	0.01	0.049	0.206	0.06	0.02	0.02	0.01
Nitrite nitrogen (mg/L as N)	27	0.02	--	*0.01	*0.02	*0.01	*0.01	*0.008	*0.0
Nitrite + nitrate nitrogen (mg/L as N)	27	0.25	--	*0.078	*0.246	*0.11	*0.05	*0.03	*0.0
Ammonia + organic nitrogen (mg/L as N)	27	1.5	0.46	0.721	1.3	0.77	0.7	0.58	0.49
Total phosphorus (mg/L as P)	27	0.06	0.01	0.032	0.06	0.04	0.03	0.02	0.01
Arsenic (µg/L as As)	2	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	2	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	2	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	2	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	2	2	2	--	--	--	--	--	--
Lead (µg/L as Pb)	2	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	2	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	2	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	27	620	330	463.704	612	510	460	420	338
Zinc (µg/L as Zn)	2	10	5	--	--	--	--	--	--

Site SW-3

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	3	94	57	--	--	--	--	--	--
Magnesium (mg/L as Mg)	3	5	3	--	--	--	--	--	--
Sodium (mg/L as Na)	3	43	19	--	--	--	--	--	--
Potassium (mg/L as K)	3	2.1	0.8	--	--	--	--	--	--
Chloride (mg/L as Cl)	3	68	30	--	--	--	--	--	--
Sulfate (mg/L as SO_4)	3	9.3	8.1	--	--	--	--	--	--
Fluoride (mg/L as F)	3	0.3	0.1	--	--	--	--	--	--
Dissolved solids (mg/L)	3	419	257	--	--	--	--	--	--
Hardness (mg/L as $CaCO_3$)	3	260	150	--	--	--	--	--	--
Silica (mg/L as SiO_2)	3	14	9.6	--	--	--	--	--	--
Color (Pt-Co units)	3	240	70	--	--	--	--	--	--
Organic nitrogen (mg/L as N)	3	4.6	0.79	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	3	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	3	4.8	0.79	--	--	--	--	--	--
Total phosphorus (mg/L as P)	3	0.51	0.03	--	--	--	--	--	--
Strontium (µg/L as Sr)	3	370	240	--	--	--	--	--	--

Site SW-4

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit.
Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	31	92	66	77.226	89.6	82	77	73	67.2
Magnesium (mg/L as Mg)	31	6.3	3.4	5.032	6.12	5.6	5.1	4.8	3.46
Sodium (mg/L as Na)	31	45	18	35.032	44.4	38	36	32	21.6
Potassium (mg/L as K)	31	1.7	0.44	1.282	1.64	1.5	1.3	1.1	0.53
Chloride (mg/L as Cl)	31	69	25	54.516	68.4	61	57	51	26.8
Sulfate (mg/L as SO_4)	31	49	8.9	15.932	37	17	14	13	9.56
Fluoride (mg/L as F)	31	0.4	0.1	0.198	0.4	0.2	0.2	0.2	0.1
Dissolved solids (mg/L)	31	381	290	348.645	377.4	366	356	335	295.4
Hardness (mg/L as $CaCO_3$)	31	250	180	213.871	244	230	210	200	186
Silica (mg/L as SiO_2)	31	20	4.5	11.848	18.2	14	13	8.8	4.56
Color (Pt-Co units)	31	110	40	54.194	92	60	50	45	40
Organic nitrogen (mg/L as N)	31	1.4	0.44	0.72	1.154	0.8	0.7	0.62	0.45
Ammonia nitrogen (mg/L as N)	31	0.42	--	*0.096	*0.396	*0.16	*0.03	*0.02	*0.0
Nitrite nitrogen (mg/L as N)	31	0.03	--	*0.008	*0.024	*0.01	*0.006	*0.004	*0.0
Nitrite + nitrate nitrogen (mg/L as N)	31	0.26	--	*0.059	*0.242	*0.08	*0.03	*0.02	*0.0
Ammonia + organic nitrogen (mg/L as N)	31	1.6	0.45	0.815	1.36	0.92	0.82	0.64	0.47
Total phosphorus (mg/L as P)	31	0.18	0.01	0.036	0.12	0.05	0.03	0.02	0.01
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	31	520	340	440.645	520	480	450	400	346
Zinc (µg/L as Zn)	4	--	--	--	--	--	--	--	--

Site SW-5

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	24	100	32	66.708	99.25	82.75	68	47.25	34.25
Magnesium (mg/L as Mg)	24	6.9	2	4.725	6.875	6.375	5.35	2.9	2.15
Sodium (mg/L as Na)	24	48	12	32.292	48	46.75	36	17	12.75
Potassium (mg/L as K)	24	2.5	1.3	1.825	2.5	2	1.8	1.5	1.32
Chloride (mg/L as Cl)	24	78	21	51.542	77.75	72.75	58.5	28	22
Sulfate (mg/L as SO_4)	24	32	7.7	18.388	31.75	24.5	19.5	11	7.95
Fluoride (mg/L as F)	24	0.4	--	*0.183	*0.4	*0.2	*0.2	*0.1	*0.05
Dissolved solids (mg/L)	24	453	168	315.625	450.75	400.25	337.5	215.25	173.75
Hardness (mg/L as $CaCO_3$)	24	280	88	187	277.5	237.5	190	132.5	93.5
Silica (mg/L as SiO_2)	24	18	3.2	8.3	17	10	7	5.475	3.22
Color (Pt-Co units)	24	180	30	67.083	165	87.5	55	40	30
Organic nitrogen (mg/L as N)	24	3.4	0.48	1.199	3.2	1.2	1.03	0.808	0.52
Ammonia nitrogen (mg/L as N)	24	0.07	--	*0.031	*0.065	*0.04	*0.03	*0.02	*0.0
Nitrite nitrogen (mg/L as N)	24	0.01	--	*0.01	*0.01	*0.01	*0.01	*0.01	*0.01
Nitrite + nitrate nitrogen (mg/L as N)	24	0.39	0.02	0.084	0.33	0.12	0.065	0.03	0.02
Ammonia + organic nitrogen (mg/L as N)	24	3.5	0.52	1.215	3.275	1.2	1.05	0.838	0.55
Total phosphorus (mg/L as P)	24	0.29	--	*0.055	*0.26	*0.05	*0.03	*0.02	*0.0
Strontium (µg/L as Sr)	24	700	200	455.417	690	580	505	292.5	215

Site SW-6

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	32	90	25	57.188	89.35	72.75	58	40.5	26.3
Magnesium (mg/L as Mg)	32	6.5	1.8	4.019	6.435	5.825	3.55	2.7	1.8
Sodium (mg/L as Na)	32	48	10	25.719	45.4	38.5	21.5	15.25	10.65
Potassium (mg/L as K)	32	2.7	0.96	1.608	2.44	1.8	1.6	1.225	0.98
Chloride (mg/L as Cl)	32	76	17	41.969	71.45	60.75	36.5	26	17.65
Sulfate (mg/L as SO_4)	32	25	0.2	13.341	24.35	20	12	7.1	2.41
Fluoride (mg/L as F)	32	0.4	--	*0.157	*0.4	*0.2	*0.1	*0.079	*0.04
Dissolved solids (mg/L)	32	429	141	274.219	414.05	352.5	262	194.5	143.6
Hardness (mg/L as $CaCO_3$)	32	250	70	159.406	250	200	165	112.5	73.25
Silica (mg/L as SiO_2)	32	19	2.7	7.009	15.750	9	6.05	4.25	2.83
Color (Pt-Co units)	32	200	30	72.188	161	95	60	40	30
Organic nitrogen (mg/L as N)	31	1.2	0.49	0.892	1.2	0.98	0.93	0.76	0.52
Ammonia nitrogen (mg/L as N)	31	0.1	--	*0.035	*0.076	*0.05	*0.04	*0.02	*0.0
Nitrite nitrogen (mg/L as N)	32	0.02	--	*0.009	*0.013	*0.01	*0.009	*0.008	*0.0
Nitrite + nitrate nitrogen (mg/L as N)	32	3	--	*0.152	*1.16	*0.095	*0.055	*0.03	*0.0
Ammonia + organic nitrogen (mg/L as N)	31	1.2	0.53	0.924	1.2	1	0.97	0.8	0.56
Total phosphorus (mg/L as P)	32	0.09	--	*0.025	*0.064	*0.03	*0.02	*0.011	*0.0
Arsenic (µg/L as As)	4	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	4	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	4	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	4	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	4	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	4	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	4	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	4	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	4	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	32	620	130	378.438	613.5	517.5	365	260	156
Zinc (µg/L as Zn)	4	--	--	--	--	--	--	--	--

Site SW-7

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	6	96	59	72.667	96	80.25	73	59.75	59
Magnesium (mg/L as Mg)	6	5	2.8	4.2	5	4.85	4.5	3.4	2.8
Sodium (mg/L as Na)	6	30	15	21.5	30	25.5	21.5	16.5	15
Potassium (mg/L as K)	6	2.5	0.1	1.017	2.5	2.05	0.7	0.175	0.1
Chloride (mg/L as Cl)	6	54	26	37.833	54	45.75	37.5	28.25	26
Sulfate (mg/L as SO_4)	6	57	28	39.333	57	56.25	32.5	29.5	28
Fluoride (mg/L as F)	6	0.7	--	*0.255	*0.7	*0.4	*0.2	*0.082	*0.02
Dissolved solids (mg/L)	6	417	272	328.833	417	363.75	323.5	286.25	272
Hardness (mg/L as $CaCO_3$)	6	260	160	200	260	222.5	205	160	160
Silica (mg/L as SiO_2)	6	13	3.4	7.517	13	12.25	6.45	3.7	3.4
Color (Pt-Co units)	6	160	30	60.833	160	92.5	37.5	30	30
Organic nitrogen (mg/L as N)	6	1.3	0.83	0.938	1.3	1.037	0.855	0.838	0.83
Ammonia nitrogen (mg/L as N)	6	--	--	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	6	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	6	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	6	1.3	0.83	0.947	1.3	1.075	0.855	0.838	0.83
Total phosphorus (mg/L as P)	6	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	6	700	400	608.333	700	700	640	527.5	400

Site SW-8

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit.
Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	10	89	26	63.8	89	84	63	52	26
Magnesium (mg/L as Mg)	10	3.8	1.2	2.86	3.8	3.6	2.85	2.375	1.2
Sodium (mg/L as Na)	10	23	5.5	15.66	23	19	17	10.275	5.5
Potassium (mg/L as K)	10	5.3	0.18	1.728	5.3	1.725	1.45	1.2	0.18
Chloride (mg/L as Cl)	10	40	8.9	27.29	40	34.75	29.5	17	8.9
Sulfate (mg/L as SO_4)	10	29	7.5	18.65	29	22.25	18	15.25	7.5
Fluoride (mg/L as F)	10	--	--	--	--	--	--	--	--
Dissolved solids (mg/L)	10	345	134	266.7	345	316	277	231	134
Hardness (mg/L as $CaCO_3$)	10	240	70	173	240	230	170	142.5	70
Silica (mg/L as SiO_2)	10	7.8	2.8	4.65	7.8	5.825	4.15	3.5	2.8
Color (Pt-Co units)	10	220	60	110	220	142.5	95	70	60
Organic nitrogen (mg/L as N)	9	1.4	0.61	0.979	1.4	1.2	0.88	0.84	0.61
Ammonia nitrogen (mg/L as N)	9	0.07	0.01	0.033	0.07	0.055	0.02	0.015	0.01
Nitrite nitrogen (mg/L as N)	9	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	9	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	9	1.5	0.65	1.018	1.5	1.25	0.92	0.86	0.65
Total phosphorus (mg/L as P)	9	0.05	--	*0.036	*0.05	*0.045	*0.04	*0.028	*0.02
Arsenic (µg/L as As)	2	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	2	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	2	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	2	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	2	3	1	--	--	--	--	--	--
Lead (µg/L as Pb)	2	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	2	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	2	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	9	560	130	396.667	560	530	380	330	130
Zinc (µg/L as Zn)	2	40	9	--	--	--	--	--	--

Site SW-9

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	4	52	38	--	--	--	--	--	--
Magnesium (mg/L as Mg)	4	3.9	1.4	--	--	--	--	--	--
Sodium (mg/L as Na)	4	27	11	--	--	--	--	--	--
Potassium (mg/L as K)	4	2	0.5	--	--	--	--	--	--
Chloride (mg/L as Cl)	4	43	19	--	--	--	--	--	--
Sulfate (mg/L as SO_4)	4	24	6.4	--	--	--	--	--	--
Fluoride (mg/L as F)	4	--	--	--	--	--	--	--	--
Dissolved solids (mg/L)	4	249	163	--	--	--	--	--	--
Hardness (mg/L as $CaCO_3$)	4	150	110	--	--	--	--	--	--
Silica (mg/L as SiO_2)	4	11	3.6	--	--	--	--	--	--
Color (Pt-Co units)	4	240	20	--	--	--	--	--	--
Organic nitrogen (mg/L as N)	2	0.9	0.8	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	2	0.05	0.01	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	2	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	2	0.05	0.02	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	2	0.95	0.81	--	--	--	--	--	--
Total phosphorus (mg/L as P)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	4	440	230	--	--	--	--	--	--

Site SW-10

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit.
Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maxi-mum	Mini-mum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	10	68	38	55.2	68	60.25	57.5	50	38
Magnesium (mg/L as Mg)	10	3.5	2.1	3.04	3.5	3.35	3.05	2.85	2.1
Sodium (mg/L as Na)	10	32	14	20.3	32	24.5	18	15.75	14
Potassium (mg/L as K)	10	1.9	0.9	1.39	1.9	1.6	1.35	1.25	0.9
Chloride (mg/L as Cl)	10	57	24	36.8	57	43.5	36	27.75	24
Sulfate (mg/L as SO_4)	10	22	5.1	10.2	22	12	8.35	6.825	5.1
Fluoride (mg/L as F)	10	1	--	*0.207	*1	*0.3	*0.1	*0.031	*0.01
Dissolved solids (mg/L)	10	339	187	263.5	339	284.250	270	228.5	187
Hardness (mg/L as $CaCO_3$)	10	180	100	149	180	162.5	160	135	100
Silica (mg/L as SiO_2)	10	7.6	2.3	5.74	7.6	6.9	6.2	5.15	2.3
Color (Pt-Co units)	10	100	40	61	100	65	60	50	40
Organic nitrogen (mg/L as N)	9	1.1	0.75	0.904	1.1	1.05	0.85	0.78	0.75
Ammonia nitrogen (mg/L as N)	9	0.1	--	*0.045	*0.1	*0.07	*0.04	*0.015	*0.0
Nitrite nitrogen (mg/L as N)	9	0.01	--	*0.01	*0.01	*0.01	*0.01	*0.01	*0.01
Nitrite + nitrate nitrogen (mg/L as N)	9	0.07	--	*0.026	*0.07	*0.035	*0.02	*0.011	*0.0
Ammonia + organic nitrogen (mg/L as N)	9	1.2	0.77	0.953	1.2	1.1	0.89	0.84	0.77
Total phosphorus (mg/L as P)	9	0.12	0.02	0.047	0.12	0.055	0.03	0.03	0.02
Arsenic (µg/L as As)	5	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	5	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	5	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	5	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	5	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	5	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	5	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	5	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	5	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	10	440	250	345	440	382.5	340	320	250
Zinc (µg/L as Zn)	5	--	--	--	--	--	--	--	--

Site SW-20

[Asterisk indicates value is estimated by using a log-probability regression to predict the values of data below the detection limit. Abbreviations: mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	7	97	38	68.714	97	83	68	57	38
Magnesium (mg/L as Mg)	7	8.2	2	5.229	8.2	7.9	5.2	3.2	2
Sodium (mg/L as Na)	7	60	14	37	60	53	38	19	14
Potassium (mg/L as K)	7	2.1	1.2	1.729	2.1	1.9	1.9	1.4	1.2
Chloride (mg/L as Cl)	7	90	23	59.286	90	76	62	33	23
Sulfate (mg/L as SO_4)	7	50	11	32.143	50	36	32	29	11
Fluoride (mg/L as F)	7	0.2	--	*0.2	*0.2	*0.2	*0.2	*0.2	*0.2
Dissolved solids (mg/L)	7	494	171	364.714	494	440	404	271	171
Hardness (mg/L as $CaCO_3$)	7	280	100	194.286	280	240	190	160	100
Silica (mg/L as SiO_2)	7	16	3.9	10.929	16	13	12	9.2	3.9
Color (Pt-Co units)	7	120	30	54.286	120	60	40	40	30
Organic nitrogen (mg/L as N)	6	0.85	0.6	0.663	0.85	0.73	0.62	0.6	0.6
Ammonia nitrogen (mg/L as N)	6	0.13	0.02	0.043	0.13	0.07	0.02	0.02	0.02
Nitrite nitrogen (mg/L as N)	6	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	6	0.15	0.03	0.09	0.15	0.127	0.09	0.053	0.03
Ammonia + organic nitrogen (mg/L as N)	6	0.98	0.62	0.707	0.98	0.8	0.64	0.62	0.62
Total phosphorus (mg/L as P)	6	0.1	0.03	0.055	0.1	0.077	0.05	0.03	0.03
Arsenic (µg/L as As)	7	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	7	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	7	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	7	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	7	6	2	2.714	6	3	2	2	2
Lead (µg/L as Pb)	7	2	--	*1.155	*2	*2	*1	*0.61	*0.47
Mercury (µg/L as Hg)	7	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	7	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	7	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	7	570	160	417.143	570	520	480	270	160
Zinc (µg/L as Zn)	7	40	--	*10.403	*40	*10	*7	*1.81	*1.01

Site SW-21

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maxi-mum	Mini-mum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	4	100	63	--	--	--	--	--	--
Magnesium (mg/L as Mg)	4	5.1	2.6	--	--	--	--	--	--
Sodium (mg/L as Na)	4	32	18	--	--	--	--	--	--
Potassium (mg/L as K)	4	2.8	1.1	--	--	--	--	--	--
Chloride (mg/L as Cl)	4	52	30	--	--	--	--	--	--
Sulfate (mg/L as SO_4)	4	22	5.7	--	--	--	--	--	--
Fluoride (mg/L as F)	4	0.2	0.1	--	--	--	--	--	--
Dissolved solids (mg/L)	4	417	264	--	--	--	--	--	--
Hardness (mg/L as $CaCO_3$)	4	270	170	--	--	--	--	--	--
Silica (mg/L as SiO_2)	4	23	9.1	--	--	--	--	--	--
Color (Pt-Co units)	4	110	40	--	--	--	--	--	--
Organic nitrogen (mg/L as N)	4	1	0.48	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	4	0.2	0.01	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	4	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	4	1.2	0.49	--	--	--	--	--	--
Total phosphorus (mg/L as P)	4	--	--	--	--	--	--	--	--
Arsenic (µg/L as As)	2	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	2	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	2	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	2	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	2	2	2	--	--	--	--	--	--
Lead (µg/L as Pb)	2	2	1	--	--	--	--	--	--
Mercury (µg/L as Hg)	2	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	2	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	4	520	270	--	--	--	--	--	--
Zinc (µg/L as Zn)	2	--	--	--	--	--	--	--	--

Site SW-22

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	1	61	--	--	--	--	--	--	--
Magnesium (mg/L as Mg)	1	2.7	--	--	--	--	--	--	--
Sodium (mg/L as Na)	1	14	--	--	--	--	--	--	--
Potassium (mg/L as K)	1	1.2	--	--	--	--	--	--	--
Chloride (mg/L as Cl)	1	24	--	--	--	--	--	--	--
Sulfate (mg/L as SO_4)	1	18	--	--	--	--	--	--	--
Fluoride (mg/L as F)	1	0.1	--	--	--	--	--	--	--
Dissolved solids (mg/L)	1	258	--	--	--	--	--	--	--
Hardness (mg/L as $CaCO_3$)	1	160	--	--	--	--	--	--	--
Silica (mg/L as SiO_2)	1	6.4	--	--	--	--	--	--	--
Color (Pt-Co units)	1	60	--	--	--	--	--	--	--
Organic nitrogen (mg/L as N)	1	0.6	--	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	1	0.15	--	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	1	0.01	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	1	0.03	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	1	0.75	--	--	--	--	--	--	--
Total phosphorus (mg/L as P)	1	0.07	--	--	--	--	--	--	--
Arsenic (µg/L as As)	1	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	1	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	1	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	1	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	1	1	--	--	--	--	--	--	--
Lead (µg/L as Pb)	1	2	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	1	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	1	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	1	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	1	350	--	--	--	--	--	--	--
Zinc (µg/L as Zn)	1	5	--	--	--	--	--	--	--

Site SW-23

[mg/L, milligrams per liter; Pt-Co, platinum-cobalt; µg/L, micrograms per liter]

Constituent or characteristic	Descriptive statistics				Percent of samples in which values were less than or equal to those shown				
	Sample size	Maximum	Minimum	Mean	95%	75%	50%	25%	5%
Calcium (mg/L as P)	2	64	58	--	--	--	--	--	--
Magnesium (mg/L as Mg)	2	4.4	3.9	--	--	--	--	--	--
Sodium (mg/L as Na)	2	26	22	--	--	--	--	--	--
Potassium (mg/L as K)	2	1.6	0.91	--	--	--	--	--	--
Chloride (mg/L as Cl)	2	41	36	--	--	--	--	--	--
Sulfate (mg/L as SO_4)	2	13	12	--	--	--	--	--	--
Fluoride (mg/L as F)	2	0.2	0.1	--	--	--	--	--	--
Dissolved solids (mg/L)	2	279	254	--	--	--	--	--	--
Hardness (mg/L as $CaCO_3$)	2	180	160	--	--	--	--	--	--
Silica (mg/L as SiO_2)	2	10	6.3	--	--	--	--	--	--
Color (Pt-Co units)	2	80	40	--	--	--	--	--	--
Organic nitrogen (mg/L as N)	2	0.72	0.62	--	--	--	--	--	--
Ammonia nitrogen (mg/L as N)	2	0.12	0.12	--	--	--	--	--	--
Nitrite nitrogen (mg/L as N)	2	--	--	--	--	--	--	--	--
Nitrite + nitrate nitrogen (mg/L as N)	2	--	--	--	--	--	--	--	--
Ammonia + organic nitrogen (mg/L as N)	2	0.84	0.74	--	--	--	--	--	--
Total phosphorus (mg/L as P)	2	0.05	0.04	--	--	--	--	--	--
Arsenic (µg/L as As)	2	--	--	--	--	--	--	--	--
Beryllium (µg/L as Be)	2	--	--	--	--	--	--	--	--
Cadmium (µg/L as Cd)	2	--	--	--	--	--	--	--	--
Chromium (µg/L as Cr)	2	--	--	--	--	--	--	--	--
Copper (µg/L as Cu)	2	--	--	--	--	--	--	--	--
Lead (µg/L as Pb)	2	--	--	--	--	--	--	--	--
Mercury (µg/L as Hg)	2	--	--	--	--	--	--	--	--
Nickel (µg/L as Ni)	2	--	--	--	--	--	--	--	--
Selenium (µg/L as Se)	2	--	--	--	--	--	--	--	--
Strontium (µg/L as Sr)	2	340	300	--	--	--	--	--	--
Zinc (µg/L as Zn)	2	--	--	--	--	--	--	--	--